Udyant Kumar

Building a Knowledge Management System for Content Sharing with Customers

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Author(s)	Udyant Kumar
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The objective of this study is to build a roadmap for the design of a robust and scalable Knowledge Management System (KMS) for a small-sized IT consultancy company. The purpose of KMS is to manage knowledge sharing and transfer in the organization. The design of KMS typically depends on the needs of an organization and the selection of tools chosen for it. In this study, the aim is to share information among the users in an effective and convenient manner.

This study uses case study as its research approach. The data came from the analysis of multiple projects done by the case company and feedback on knowledge sharing by the project members, especially concerning the needs for more collaboration. Semi-structured interviews were used to collect the data on the users' needs. The KMS proposal was evaluated by internal company representatives.

The outcome of this research is a model for building a robust, scalable and full-featured KMS. A good example for management of knowledge using this type of KMS was found and scrutinized before the final proposal was developed. As practical implications of the study, a roadmap for necessary actions was proposed.

Keywords	Knowledge management, knowledge management system, collaboration tools, five-layer architecture

Contents

1 Introduction

This study concentrates on building a new Knowledge management system (KMS) for the case company which can be used in content sharing with its customers. The system should be helpful in content creation, content management, document management, intelligent filtering of content and structuring of knowledge in the ontological and taxonomic manner.

1.1 Background of Knowledge Management Systems

Knowledge management (KM) involves the management of knowledge (both terms are used in this study) that is useful and creates value for the organization, and which implies a strong tie to the organizational goals and strategy. KM involves the understanding of knowledge and its form, the knowledge needs of the organization, the ways to generate relevant knowledge, promotion of a culture for spread of knowledge, making knowledge available, and the use of knowledge to enhance performance of the organization in view of its strategic goals, opportunities and needs (Botha et al. 2008: 25-30).

Effective and efficient knowledge management is facilitated by the use of management systems (KMS), a specific technology which is represented by a combination of processes, tools and platforms. KMS is a class of information systems used to manage the organizational knowledge (Alavi and Leidner 2001: 112-114). The primary goal of using KMS is to bring knowledge from the past to be used in present activities and increase the level of the organizational effectiveness in the future (Lewin and Minton 1998: 542-545). Thus, KMS is a technological part of person-oriented and the organization instruments called knowledge management initiative which targets the improvement in productivity of knowledge work (Maier 2004: 10-12).

KMS is used to support and enhance knowledge intensive tasks, projects and processes related to knowledge creation, organization, storage, retrieval, transfer, formatting, reuse and revision (Jennex and Olfmann 2003: 207-214). KMS was

compared to a pipeline for the smooth flow of explicit knowledge through a refined process (Zack 1999: 46). The focus of this refinement is the creation of a user-centric approach for IT technology. This IT powered user-centric approach provides a basic system to capture and distribute knowledge (Jennex and Olfmann 2003: 222-224). Importantly, KMS is not an application system which targets a single KM initiative, but a platform which can be used either for supporting knowledge processes or for integrating base systems and repositories on which KM application systems are based. This platform offers functionalities for user administration, messaging, sharing of knowledge and conferencing. Other advanced services are also available in KMS, such as personalization, clustering and categorization to enhance the relevance of retrieved knowledge, advanced graphical techniques, shared workspaces, distributed services and integration of knowledge from various distributed sources (Maier 2004: 68-70).

KMS can also be used in creation and sharing of good practices. It organizes knowledge according to the principles of taxonomy and ontology; it can manage competency; it can also filter and handle knowledge used for connecting people. Thus aimed, it develops a knowledge network. It also helps in solving problems by using business analytics methods (Tsui 2003: 14-22).

In this study, KMS is designed and planned for deployment in such a way as to facilitate the sharing of information in an effective manner. The presentation of content should also be helpful and convenient to users to gain, store, share and utilize knowledge. With a KMS in place, the retrieval of knowledge should be easy. In all aspects, it should save time and money of users and enhance productivity in project or product delivery.

1.2 Case Company Background

The case company of this study is a small-sized IT consultancy company which is operating since 1999 and is located is Finland. The case company provides consultancy services to its customers in the area of CRM, business analytics and project management. Its primary work is related to providing expertise and business solutions to its customers. It provides a better design of business requirements and technical architecture of the problem of its customers. It is also involved in design and implementation of operational, analytical and collaboration customer-specific solutions.

It works mainly in customer relationship management solutions and agile project management.

The primary business partners of the case company are such companies as Outotec, Kone, Nokia and some other small and mid-size Finnish companies. By utilizing its leading CRM and business solutions, the case company helps its customers to manage customer relationships more efficiently, utilize its customer data, reach target sales and serve its customers more effectively through many other channels. The company is a Saleforce.com certified partner and Oracle Gold Partner which makes it a leader in its domain.

1.3 Research Problem and Objective

Currently, the case company is in a growth phase, and it is getting new customers continuously. To serve the existing customers and to offer solution for the new customers, the case company needs a system which can help it to share information with these customers. The lack of a strong content sharing system (a knowledge management system) leads to the situation when the case company is using a range of different IT tools and mechanisms to serve its customers which waste a lot of time and are not synchronized. Therefore, the company is looking for a robust, reliable, secure and easily maintainable system to share information or knowledge with customers. Previously, the company tried to make such a system using various standard CRM tools but failed to be successful. It seems that the reason behind this failure may be related to choosing either a wrong process, or conceptual framework, or IT tools. In short, the research problem for the company is to develop a robust, easily maintainable and less costly infrastructure to share information related to projects with its existing and new customers, and to do it in a secure way.

In business and research literature, there are many frameworks, tools and strategies available which can provide a better solution for this problem. The main challenge is related to the design of content using the tailor-made strategy and model, sharing the content in an appropriate way, and storing and presenting the content to the customers using a suitable technology. The types of systems which address this challenge are called knowledge management system (KMS). Presently, many types of knowledge management systems are available in the market which can be deployed based on the requirements from the company. Finally, since the customer base of the company will

grow and become more diverse in future, the system should also give an opportunity to increase its scale.

Thus, the objective of this study is to suggest a roadmap for the case company to build an appropriate KMS to address this challenge. This suggestion will be based on the current and future needs of the case company.

2 Method and Material

This section overviews the research approach, data collection and analysis methods utilized in this study.

2.1 Case Study Approach

The research approach applied in this Thesis is the case study method. The method is a detailed analysis of events that stresses the developmental factors related to the specific context of the event. The case study can also be defined as a research strategy, which is an enquiry that investigates the happenings in real-life situations. It can relate to a single or multiple case studies describing problems associated with the event. The case study can include both qualitative and quantitative evidence which relies on multiple sources of evidence, for example, those drawn from literature, real life environment, pilots, tests, etc. Based on this evidence, a theoretical model is typically construed. The process of building theory from the case study research is defined as a case study approach. A case study approach is used when the focus of study is placed on answering the questions such as “how” and “why”. The study explores the events having relevance to real life examples when the boundaries between the event and its real life environment are not easy to define (Yin 2003).

The type of data used in this case study is qualitative. The data will be gathered by semi-structured interview, observation of processes, procedures and internal documents, evaluation of conceptual framework done in the form of feedback from the experts’ group.

The factors analyzed in the case study are mainly description of the key features of the system designed for the case company. The key features are related to the architecture, processes, functionalities, sub-systems and tools required to build those sub-systems. The outcome is a roadmap to build the system for the case company. The proposal for building the system is evaluated by the experts’ group of the case company.

2.2 Research Process and Design of This Study

The research process of this study is based on the case study logic and includes a series of steps required to solve the problem of the case company as described below:

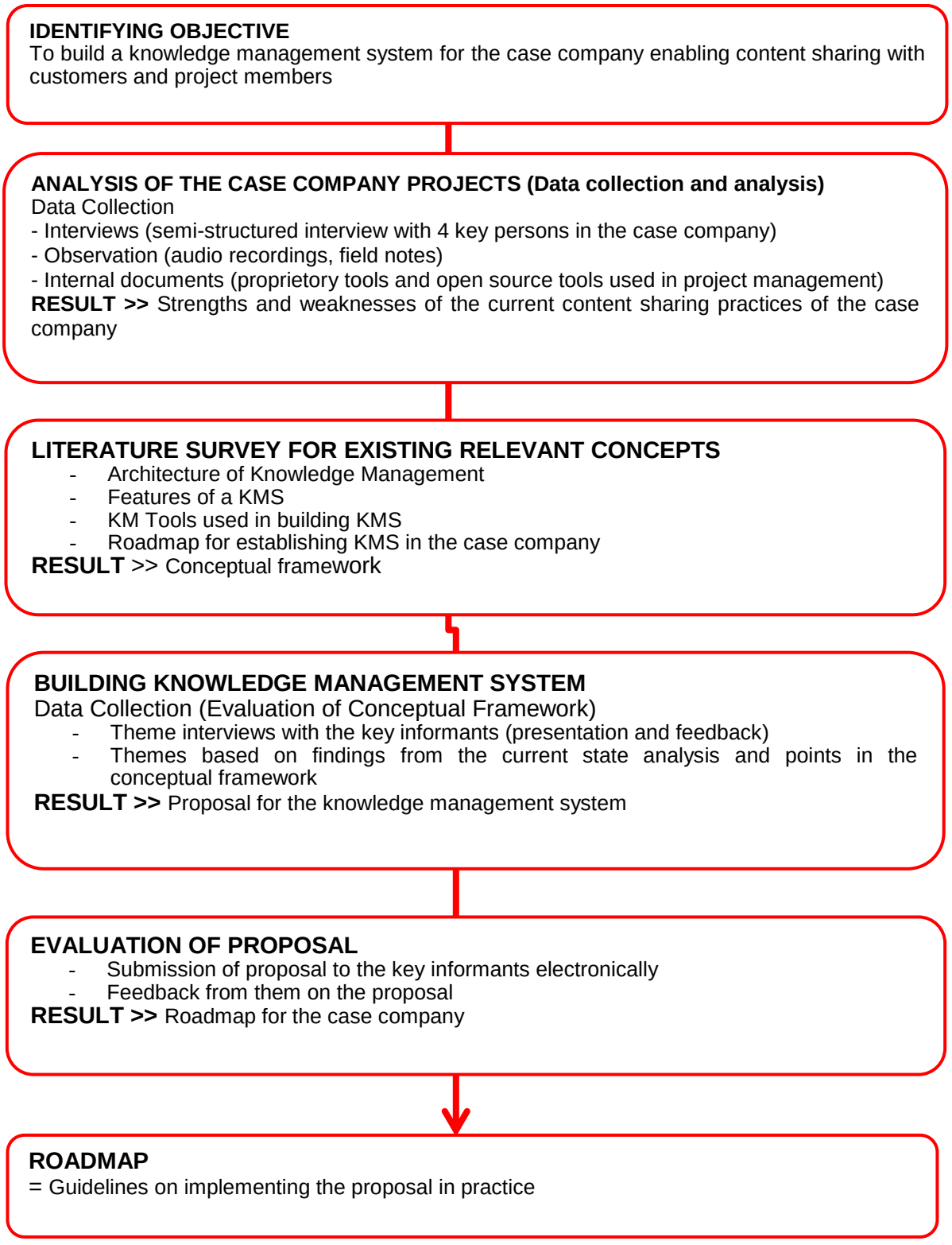

Figure 1. Research design for building KMS for the case company.

As shown in Figure 1, the first stage of research is the *identification of the problem*. This step also includes the formulation of problem. It provides a better vision for the researcher to direct his efforts and specifies the limitations. Thus, it provides a better ground for constructing a relevant roadmap.

The second step involves the analysis of multi-case projects by the case company. This step can help define the problem and secures the ground for further analysis. In this step, the data are collected from different case projects qualitatively or quantitatively. This step helps to identify the variations in problems and possible solutions, and it helps to ensure accuracy in the subsequent application of theory.

The *Literature survey* step includes the collection of relevant data from literature. In this case, the information related to the building blocks of designing a KMS for the case company will be collected from literature and interviews with key participants of the study. This step aims at specifying the architecture, list of features and useful tools for building a KMS for the case company. The information collected from literature represents best practice used for this purpose and later synthesized into the conceptual framework for this study. It also improves the proper grounding of the suggested model in theory and results in designing a framework providing a synergistic view on the KMS obtained from both theory and evidence from the case company.

The *second data collection* step is related to the interviews conducted with the key participants for the current state analysis and conceptual model of the system. Theme interview includes the step of feedback from key participants about the system based on key findings from literature used for building the system. The panel of key participants discussed the relevance of the findings against their needs. The conclusion helps to formulate the requirements for the proposal for building the KM system.

The next step is *evaluation of the proposal* by the same key participants to evaluate whether the proposal fits their need. The outcome of this evaluation process is the roadmap for building the system.

The Roadmap presents the outcome of the study, which is a list of recommendations for the case company for building an effective knowledge management system. It provides the guidelines of implementing this proposal in practice in the case company.

2.3 Data Collection and Analysis

In qualitative research, the most prominent data collection methods are observation, interviews, focus groups and questionnaires. Some other data collection techniques are performance monitoring, action planning and various measurements, such as measuring of learning, implementation, impact and consequences. Among these variations, the study adopts a current and retrospective approach to data collection. The data collection method was qualitative. It is based on semi-structured interviews; the researcher's observations of tools, methods and processes used by the case company, and the evaluation of feedback from the previous KMS piloted in the case company. Based on this evidence, enriched and strengthened by findings from the best practice available, the study suggests a roadmap for building a KMS.

The data collected for the study came from a range of sources. The main source was the semi-structured interviews conducted in the case company with the most knowledgeable experts holding senior management positions (four senior managers and experts), engaged in decision-making processes. In these interviews, the respondents were encouraged to express their opinions in their own terminology, with examples from their experience. A set of relevant properly organized questions were asked. The details of interviews are summarized in Table 1 below.

Table 1. A list of key persons from the case company for data collection.

Interview	Interview, position	Date	Duration	Documented
1	LL, partner	11/03/13	1 hr	Appendix 1
2	PL, Director, Services VP, Team Lead	12/03/13	1 hr	Appendix 2
3	TN, CEO	18/03/13	1 hr	Appendix 3

As seen from Table 1, in this research work, the data collected are more of qualitative type. Hence the best way of data collection was by conducting interviews. The interview may be structured, semi-structured or unstructured. In this case, the interviews were semi-structured theme interviews. The interviews were conducted over a time period. Also, the internal documents and tools used in the projects were analyzed in the study. This step also included the activities related to data recording and preparing filed notes from the recorded data. The mode of recording data was

audio recording in this case. It ensured that the data are collected from a variety of sources to improve reliability and validity by data triangulation.

Apart from the interviews, the researcher observed the actual use of the company IT resources, processes and technologies. The field notes prepared for the interviews and observations were used to analyze data. The observation details are presented in Tables 2 and 3 below.

Table 2. Observation of data collected from key personnel of the case company.

Case	Duration	Contents	Observation log
Case 1	11.03.2013–18.03.2013 and 05.03.2013	Semi-structured interview, tools used in projects Presentation, feedback	audio, field notes
Case 2	12.03.2013–18.03.2013 and 05.03.2013	Semi-structured interview, tools used in projects Presentation, feedback	audio, field notes
Case 3	18.03.2013 and 05.03.2013	Semi-structured interview, tools used in projects Presentation, feedback	audio, field notes

Table 2 presents a view on the mode of data collection. The first data collection was done on three different dates with three groups of informants (11th March, 12th March and 18th March). First, the data collection was done by means of semi-structured interview. The interview was recorded and the field notes were prepared from it. This was followed with the investigation of tools used in projects. The second data collection was done with the informants on 5th April. This was done to get feedback about the conceptual framework for building the system.

Table 3. Tools used by the case company in different case projects.

Case	Tool	Purpose	Contents
Case 1	Many open source tools for content creation, content management, calendaring, document management, Salesforce chatter (for communication)	Content management, document management, time management	audio, field notes

Case 2	Sharepoint, IBM Lotus for document management, some other open source tools for content creation, content management, communication and time management, Salesforce chatter (for communication)	Content management, document management, time management	audio, field notes
Case 3	Many open source tools, such as google docs, google drive, google calendar for time management, task management, document management, content creation and management	Content management, document management, time management, task management	audio, field notes

The second data collection, presented in Table 3, was done in the form of feedback collection from the key personnel listed in Table 1. In this stage, the conceptual framework for the KM system required by the case company was evaluated. The evaluation was done in the form of feedback on the architecture, sub-systems and functionalities of the planned KM system.

Although in this study the number of sources was not very representative, but the interviews, feedback, observation and examination of tools helped the researcher to analyze the needs of the case company. The four persons represented three case projects as data sources. In these interviews, all the aspects of designing a KMS were discussed.

Overall, the researcher worked as an external consultant in this project to provide a roadmap for a new system to share content with customers and other project members. For this purpose, the researcher conducted various activities such as collecting data from key the personnel of the case company and relevant information from literature. The researcher also presented a view on the previously built KMS and other tools for knowledge management used in the case company.

In this research, the evaluation of proposal for the system was also done with same group of key personnel from Table 1, in the form of feedback to make sure that the proposal meets their requirements.

2.4 Reliability and Validity

Validity of research relates to the authenticity of data. Validity can be done by collecting data in various ways: interviews, survey, questionnaire, observation, statistics and study of internal company data. Validity increases if data is collected from many and various sources. It also increases by applying replication of logic and bias reduction. To improve validity, the researcher should rely on the patterns suggested by data rather than making his own judgments before thoroughly analyzing the data. Validity can be constructed by using multiple sources of evidence to establish a chain of evidence. To validate the data even further, it can be reviewed by key stakeholders. Validation can be done internally or externally, or both. The internal validation is improved by pattern matching, building explanations, evaluating alternative explanations and using some logical models. The external validity is enhanced by finding replication logic in multiple case studies. Overall, validity can be improved by detailed data collection, data checking by informants, data reporting in details and finding patterns from data rather than making judgments beforehand.

Reliability relates to checking that the data shows uniformity in all conditions, and the same results can be obtained, if the researcher is repeated by another researcher or is done at a different point in time. Reliability includes the trustworthiness and authenticity of data. Reliability can be improved by data triangulation, increasing data richness, as well as by piloting, testing and otherwise avoiding researcher’s bias. Reliability of data collecting can be increased by including all relevant parties involved in the research. This step reduces bias and increases fairness of the data. Reliability can also be improved by using different data sources, different data collection tools, applying a well-tested theory from one area to another, data collection at different time points, by using many researchers and informants in the research, and by proper documentation and logging of data. Different data sources can be: key stakeholders, internal documents and observation existing procedures followed by the case company, among other steps. Different data collection techniques can be: interviews, survey, observation, study of internal documents and company statistics. Finally, the data collection can be done at different times, thus ensuring that the data shows uniformity in time. Involvement of many researchers and personnel also increases the replication of logic and reduces researcher’s bias.

3 Current State Analysis

This section overviews the results of the current state analysis from three projects conducted by the case company of this study, in which the researcher has worked as a consultant. The purpose of the current state analysis is to present three case projects in details and summarize the strengths and weaknesses of the tools previously used by the case company for these projects. This section also lists the strengths and weaknesses of other tools used for knowledge management in their projects.

3.1 Overview of Three Company Projects

In the past, the case company tried to build a knowledge management system but it failed to meet their requirements. The case company tried to integrate different tools offered for different functionalities, such as document management, content creation, resource management, time management and search mechanism. As the key personnel of the case company (employee A, employee B and employee C) remarked,

> "*All these different tools had different access mechanisms and different mechanisms to work. Some of them were licensed software and others were open source. The integration could not deliver the desired result*".

Since the integration was difficult and each tool lacked one or many functionalities, the system was not able to maintain document search and their different versions; the system was unable to provide a space to allow project members to discuss either; and it lacked synchronization between the tools. The system was also unable to arrange the content specific to the project and did not allow the authorized members of the project to access it. This inability to organize the content and weak search mechanism caused losses of efforts and time of the project members to look for the contents in the system. At the end, the views of the users about the system were mostly negative. In this regard, employee C of Case project C commented:

> "*The reason for the failure of the system might be attributed to the weak architecture and bad selection of tools for building it*" (Respondent T)

The previously built system and some other tools used for project delivery had many weaknesses, hence the case company needed a system which would be helpful in project delivery. In the following subsections, three case projects are discussed with the

key personnel of the case company to specify their recommendations for building a full-featured KMS which can enhance the value for the case company and its customers by reducing the project time and increasing the project members' collaboration. The details of these discussions are summarized in Appendices 1-3.

The IT system containing all these primary functionalities resemble the principles of Knowledge Management System (KMS). Hence, the aim of the company is to build a robust, reliable, intelligent and scalable KMS.

3.2 Case Project 1

In Project 1, the customer of the case company is a small company. Employee A of Case Project 1 is a consultant working for his customer. In this case, Employee A on behalf of his customers, is interested in a system which can help them in their work. Their primary aim is to store and share content with the members and customers in the project. The content can be documents, web-content, minutes of meetings, discussion, chat and task list.

Currently, the project members are using various tools for creating and managing content, documents, task lists, time, discussion and experts' views on relevant topics. This information can be used across different projects when needed. The primary tools used for these purposes are Google docs (for content creation), Google Drive (content management), Salesforce chatter (discussion forum), wikis, blogs, e-mails. These tools are having independent access management. Also they lack efficient search and browse retrieval mechanism. These tools also lack mechanism to store and search for different versions of documents. Due to these problems, it is not easy to search and share contents distributed in different tools. As Employee A of case project A (Lauri) said:

> "*Lack of single interface or access management does not allow users to share content across the projects, although they find it very useful in other projects*". (Employee A)

This clearly points to the need for the system to have single access management. The current set of tools is also unable to present the content in an organized form. Employee A tells that:

> "*All tools are having different interface. Hence content format is different. It also reduces the interest of users*". (Employee A)

The above statement stresses the need for the single access management which can also help in an organized presentation of content. Many other common functionalities for a good knowledge management system are also missing, such as wikis and blogs to share best practices used in the projects and views of different people on certain topics. This information can be stored and used in different projects as reference. It also reduces the time and efforts of the project members to redevelop those practices and contents. The Employee A says:

> "*The system with full features handling proper management of data will reduce our efforts and time. Customers will surely appreciate it*". (Employee A)

Many challenges faced by project members in Case Project 1 forces them to look for a robust and scalable KM system. Presently, Employee A does not have a clear picture about the architecture of such a system, but he suggests the system should be able to create, organize, store and share content among users. The system should have many features such as single access management, content creation, proper document handling, collaborative and communicative tools. The system should also provide a backup mechanism. Since all features cannot be found in one tool, a proper integration of tools can make it possible. In this regard, different tools for content management can be used. Primarily, the tools related to content management, document management, collaboration, conferencing, communication are looked for in this regard.

3.3 Case Project 2

Employees B and C of Case Project 2 are working as consultants for big organizations. In their opinion, the customers are using IT systems, such as IBM Lotus, Sharepoint for document storage and sharing. These tools are provided by their customers, but after gathering experience in using them, the participants and also their customers found that their system lacks many features of an IT portal which can facilitate the project execution. Employee B of Case Project 2 (Piirkka) described the problem as follows:

> "*The content stored in Sharepoint cannot be formatted in other form of contents which does not allow users to use it from anywhere*". (Employee B)

According to her, the content of the existing system is not able to be replicated in other formats. Employee C of Case Project 2 (Ville) described that the system lacked efficient search mechanism of content. According to him

> "*IBM Lotus is having very difficult search mechanism. It is also hard to find different versions of documents there*". (Employee C)

According to Employee C, the existing system lacks search mechanism. Also they pointed out that it cannot be used for some other purposes, such as management or documenting task lists and schedule for it. For many other tasks, such as web content management, backup of documents, forum, chat, they have to rely on other open source tools which is not a part of the existing infrastructure provided by customers. Also the existing infrastructure does not allow them to access the content remotely due to lack of web content format. These tools do not have basic utilities such as creating, storing and using editable web-contents, for example, wikis and blogs. For these cases they have to rely on open source technologies, which is not accepted by their customers, the primary reason behind is that different tools are having different access management. Hence it is very difficult to keep track of contents used in different tools. As Employee B and C both stated:

> "*The access management becomes different in case of various tools. Customers are unwilling to use various tools. They want everything should done on a single centralized platform*". (Employee B and C)

The other major requirement of the case company is that the system should be able to present content in web format so that it will be easy to transfer the content and best practices between different projects. Employee B stated

> "*The formatting of content is a major issue. If the content can be presented in format being used widely, it becomes easy a task to transfer information from one group or project to another. That is a necessity in handling many projects*". (Employee B)

This again underlines the need for a robust, secure and scalable system for content storage and sharing. As they said:

> "*The new system should be built using the tools, technology and architecture used earlier or alternatives used in this regard. The system should be easy to use and should handles content, tasks, communication and resource efficiently*". (Employee B)

The Employees of the Case Project want a centralized system which should have the single access management. The customers of the case company are willing to use the system if the new system benefits them. They expect that the new system should be having features, such as document management, content creation, content management of all formats of content, for example, doc, wikis, blogs, minutes of meeting, task lists, data warehousing and data mining and intelligent search mechanism.

3.4 Case Project 3

The participant of Case Project 3 (Employee D) is handling matters related to many customers. He is participating in this study on the basis of feedbacks received from the internal employees and his customers. He says:

> "*The customer is willing to try the knowledge management system provided by the case company. But the customer and project members are looking for a system having proper integration between the tools for calendaring, resource management, document management, content management, task management, communication and collaboration. The project members also want single uniform access management to this system for easy use of the system*". (Employee D)

The view of the participant is also in favor of the proper organization of the content in the system. He is in favor of granting users access rights specific to their projects. According to Employee D:

> "The c*urrent set of tools used by the case company and its customers do not have functionality to store experts' views, discussions in a document form for future reference. We are lacking mode of operation to store and reuse the best practices of a particular project in another project*". (Employee D)

The case company and its customers are looking for a system which can organize the contents according to the projects and also personalize the contents. The system should have an integrated mode of operation to create and store agenda of meeting, task lists and its time schedule. The system should also have mechanism to notify all the participants about the meetings on time.

The system should have backup mechanism which will store different versions of documents for reuse. It should facilitate the creation, storage and sharing of unstructured contents, such as FAQs, blogs. The system they are looking for should mostly depend on their need. They are not having any particular views on a proper architecture for the system, and they are also open for various existing tools useful in his tasks.

3.5 Summary

The three case projects, as described earlier in this section, inform that their case company and its customers rely on the use of a diverse set of tools for project management. This set of tools is used for document management, content management, content creation, data mining, data warehousing, search and browse retrieval, time management, resource management and experts' forum. This set of tools being used by the case company and its customers should have their own interface to access it. Thus, it becomes a tedious task to maintain their different access mechanisms. Hence is the primary need of the company to have the single access management.

In addition, the contents in these different systems vary from each other. Therefore, the format of the contents of one tool differs from another. When the content of one tool is used for another tool, the different format makes it difficult to present. This limits the transfer of contents between different projects. The document management tool also does not have efficient versioning mechanism. This prevents users from accessing the old documents when needed. The content management tool lacks efficient search mechanism which forces users to spend a lot of time on searching for the content. The tool is also lacking features to create contents and store it properly. It does not provide a platform for any user to seek expert's view on certain topic. Finally, there no proper integration between all these tools. Hence, in case of an integrated system to manage time and task is missing.

The problems mentioned above forces the case company to build a system to create, store and share content with its users, particularly with customers specific to their projects. The important functionality of this tool should be a centralized architecture and single access management. The tools used for other functionality of this system should be integrated properly. This makes task easier for users to look for contents or tools. The shared content should be documents, minutes of meetings, calendar, task list, experts' opinions, discussion, blogs and wikis. The content can be presented in project specific directory. Users have access rights specific to their projects. The system should have an integrated mechanism to store the time of meetings, their agenda and task schedule. They can be informed to the project members about agenda by sending notification by e-mails. The system should provide a place for chat also so that the project members can discuss the topic instantly.

Based on needs of the above mentioned three case projects, it can be concluded that the problem for the case company is to build a knowledge management system to manage knowledge in a proper way. A list of needs or priorities of the case company and its customers can be summarized as follows:

Table 4. A list of functionalities by key personnel of the case company for a system.

List of priorities for a system to be designed for the case company
Centralized System
Single access management
Document Management (document according to projects, versioning)
Content Management (content creation, store, share and reuse)
Efficient Search and browse retrieval
Presentation of content according to project specific directory structure
Access for content from remote location
Time management (calendar)
Task Management (tool to manage task list)
Notification mechanism about task and its timing (by e-mail)
Integration of tools
data Warehousing
Easy usability

As shown in Table 4, the case company was looking for a new system with better architecture, useful features, knowledge management models and knowledge management processes. Such a system should be helpful in storing and sharing information, such as documents, best practices, FAQs, discussion, minutes of meeting, task lists, and time schedule; and it should be able to transfer the practices of one project into another. It should also provide an opportunity to share knowledge with customers in project delivery. It should be a centralized system, with a single-sing on access management. The tools used in the design of this system should be integrated properly. The system should allow users to create, modify and delete the content with ease. The knowledge repositories should have good backup mechanism. The search mechanism of the system should be very intelligent. Finally, the presentation of content should be well-organized.

Based on above mentioned three case projects, it can be concluded that KMS that the company needs must be built on the above functionalities. After these discussions, the architecture of KMS was still not clear, though the basic principles of the architecture of the system were established. They also wanted to explore different tools used in building the system, therefore the researcher examined the best practice and available literature on knowledge management systems and suggested a conceptual framework for the system development.

The results of the review of best practice and available literature on the knowledge management systems are discussed in the subsequent section.

4 Conceptual Framework for Building Knowledge Management System

The outcome of the current state analysis suggests that the case company needs a system which can manage different forms of content. The contents may be concepts, procedures, technical information, products, services, FAQs, forums, wikis, blogs. The system should store and share content with users with ease. The system should also have the necessary functions described in brief in the current state analysis. The outcome calls for a robust, reliable and scalable Knowledge Management System (KMS). The building of such a KMS needs proper explanation of knowledge and knowledge management (KM).

This section discusses the current views on knowledge, knowledge management and knowledge management systems available in business and research literature. It also suggests an initial framework to start the development of a knowledge management system for the case company. This initial framework consists of the architecture, functionalities and KM tools which would be used to build the system.

4.1 Key Concepts of Knowledge Management

Knowledge is a mix of framed experience, value, contextual data and expert opinion that gives an environment for evaluating and incorporating new information and experiences. It originates in the mind of knowledge-workers and can then be documented and put in repositories. Later on it can be embedded in the organizational routines, practices and norms (Gambel and Blackwell 2001: 23-24).

Knowledge Management (KM) is the systematic management of knowledge assets of an organization with the purpose of creating value for it. The result will meet the strategic and tactical requirements of the organization. Knowledge management consists of the initiatives, processes and strategies and system that sustain and enhance the creation, storage, analysis, sharing and reuse of knowledge (Gambel and Blackwell 2001: 52-54).

Knowledge Management System (KMS) is an IT system that store and retrieves knowledge, locate and collaborate with knowledge sources, mines repositories for hidden information, captures and uses knowledge, and enhances KM process (Bali et al. 2009: 23-26).

4.1.1 Knowledge

Knowledge can also be described as personalized information in corporate world which is related to facts, processes, procedures, concepts, ideas, interpretations, observations and judgments (Devenport and Prusak 2000: 17-21).

Information is contextualized, calculated and condensed into data with relevance and purpose. It generally conveys a trend in the environment but is explained in general terms, not specific term (Devenport and Prusak 2000: 78-81, Bali et al. 2009: 67-70).

Compared to information, knowledge is organized, collected and embedded in a context of application in a meaningful way (Devenport and Prusak 2000: 83-85). Knowledge is more related to doing and implying know-how and understanding of information. If broadly described, knowledge is typically divided into two types: *tacit* and *explicit*. *Tacit knowledge* is difficult to articulate and it cannot be converted into words easily. *Explicit knowledge* is the content captured and stored in tangible forms such as words, audio or video recording, images etc. Examples of explicit knowledge may be customer feedbacks, customer reactions, e-mail conversation, frequently asked questions, weak signals leading to innovation. Table 5 below summarizes the difference between these two types of knowledge.

Table 5. A comparison of Tacit and Explicit Knowledge (Dalkir 2005: 5).

Properties of Tacit Knowledge	**Properties of Explicit Knowledge**
• Ability to adapt and deal with new and different situations • Know-how, Know-why and care-why (Expertise) • Ability to collaborate, to share a vision, to transmit a culture • Mentoring to transfer experimental knowledge on face-to-face basis	• Ability to disperse, to reproduce, and to reapply throughout the organization • Ability to teach, train • Ability to organize, to translate a vision into a mission, into operational guidelines • transfer of knowledge via tangible forms of method e.g. Products, services, documents •

As seen from Table 5, tacit knowledge mostly resides in the mind of knowledge-workers and very difficult to codify, whereas explicit knowledge can be codified, documented, stored and shared. Hence tacit knowledge can be transferred between

people by communication or discussion and then converted in explicit knowledge by creating, for example, documentation if required. Explicit knowledge can be shared by any available methods such as using information technology (IT).

4.1.2 KM and KM Process

Knowledge Management (KM) can be defined as a collaborative and integrated approach to create, capture, organize, access and use the knowledge assets of an organization (Grey 1996). In simple words, KM can be considered as a mix of strategies, tools and technologies.

KM focuses on organizing and presenting knowledge to the place where it is needed most. It focuses on managing both forms of knowledge, tacit and explicit. The resources being managed are labeled as knowledge capital. The knowledge capital of an organization can reside inside or outside the domain of the organization. The knowledge capital of an organization are human capital (skills and capabilities possessed by individuals), the organizational capital (databases, manuals, culture, systems, structures and processes) and social capital (knowledge embedded in relationship between individuals) (Subramaniam and Youndt 2005: 456-457).

KM has impact on people, processes, products and the organizational performance. KM influences people in many ways. It can facilitate their learning, make them more flexible and enhances their job satisfaction. KM helps people to learn by providing exposure to the latest knowledge in their fields. It also encourages them to become more adaptable by learning from each other. This helps them to learn faster than the people working in the organization which lacks KM and better preparing them for changes. This impact makes them to adapt faster because of skill enhancement and knowledge acquisition.

KM impacts the organizational processes in many dimensions: effectiveness, efficiency and innovation. It improves the process effectiveness by performing the most suitable process and making the best decision. It improves the process efficiency by performing the process quickly in cost/effective manner. It improves the process innovation by performing the process in a creative manner which improves the effectiveness and efficiency. It also improves the organizational process by imparting knowledge to individuals and providing a provision for workable solutions.

KM impacts the organization's products in two respects: value-added products (goods or products) and knowledge-based products (services). KM can offer different processes to deliver new products with better quality than its previous version. It can also improve the processes to deliver better quality services.

KM can impact the organizational performance directly or indirectly. The direct impact on the organizational performance occurs when the knowledge is used to create new and innovative products and generate revenue for the organization. The generation of value or revenue is directly linked with the objective, vision and strategy of the organization. The indirect impact on the organizational performance is related to the activities that are not directly linked to the vision, strategy and revenue of the organization. In this case, the intellectual capability of the organization is addressed (Bacera-Fernandez and Sabherwal 2010: 71-81).

The positive effect of KM on the organization in terms of people, product, efficiency and performance of the organization can be achieved by better aligning KM processes with the vision and objectives of the organization. KM process consists of *knowledge discovery, knowledge organization, knowledge creation, knowledge sharing* and *knowledge reuse* (Bacera-Fernandez and Sabherwal 2010: 56-57).

Knowledge Discovery process deals with discovering the knowledge that an organization possesses. Once knowledge is created, it should be shared and reused. But for proper use of knowledge it should be detected properly. Explicit knowledge is discovered from documents, processes, and other data repositories. IT can be used to find hidden knowledge by analyzing patterns in data and text. Many tools such as intelligent mining, data mining, text mining can be used for this purpose. Tacit knowledge often resides in the mind of knowledge-workers. Hence discovering tacit knowledge is a more complex task. In this case, management and IT is used to identify the experts and groups. Some methods such as questionnaire, FAQ, discussion forum, interviews, observation can be used to identify tacit knowledge. The knowledge can be identified from various sources such as alliances, suppliers, customers. Knowledge from alliances and partners can exist in joint projects, shared knowledge experts operation etc. Knowledge from suppliers and customers come in the form of feedback, trends, developments etc. IT can be used for feedback and communication from customers and gathering and analyzing data and information related to projects.

Knowledge Organization is done to know the strengths and weaknesses of knowledge at its disposal. Knowledge is organized in some valuable format which can easily be

managed. This step includes activities such as classification, mapping, indexing and categorizing knowledge for navigation, storage and retrieval (Botha et al. 2008: 111-117). The explicit knowledge is organized and retrieved by using taxonomies and ontologies. The methods used in categorization create a logical and hierarchical knowledge map. Some methods use libraries and data mart. The tacit knowledge is organized by using focus group, expert forums, social network groups and knowledge coordinators (Gamble and Blackwell 2001: 89-93).

Knowledge Creation is achieved by adopting better practice, collaboration, interaction and education between individuals. The relevant data and information play a role of building blocks in creation of new knowledge. The management can play a pivotal role in knowledge creation by enabling and encouraging knowledge sharing, creating a suitable work atmosphere, providing infrastructure which supports the work process and making information and data available to knowledge-workers on time. The knowledge can be created by converting tacit into explicit and then documenting it. IT plays an important role in transfer of all knowledge types into explicit knowledge. IT provides both formal and informal collaboration for knowledge creation (Davenport and Prusak 2000: 67-69).

Knowledge Sharing is about making right information for right people. Knowledge sharing is the most important KM process because a vast majority of KM initiatives depend upon it. Knowledge sharing mechanism can be either push or pull. The pull knowledge relates to the situation when the knowledge worker actively seeks out knowledge sources (e.g. library search, seeking out help from an expert, collaborating with a coworker, etc.), while knowledge push occurs when knowledge is "pushed onto" the user (e.g. newsletters, unsolicited publications) (Bukowitz and Williams 1999: 58-61). Knowledge sharing depends on the habits and interests of the knowledge worker to seek out or be receptive to knowledge sources. Thus, the culture, rewards and incentives need to be therefore present to facilitate knowledge sharing. Successful knowledge sharing can be determined by A*rticulation* **(**the properly defined needs of users), *Awareness* of the knowledge available, *Access* to the knowledge, *Guidance* (experience of knowledge managers in the design of a knowledge sharing system) and *Completeness* (access to both centrally managed and self-published knowledge) (Bukowitz and Williams 1999: 72-73). For successful knowledge creation, knowledge managers have to define the areas of expertise of the members, provide guidelines to the contributions, help users, and take responsibility for the language used in publications and other communication material. IT can play an important role in sharing

both explicit and tacit knowledge. It uses content management, document management, data mining and text mining tools for sharing explicit knowledge. IT can use expert finder tool to share tacit knowledge. It can also externalize tacit knowledge by using tools such as forums, chat rooms (Botha et al. 2008: 54-55).

Knowledge Reuse is about using the previously created or used knowledge in different environment. There are three primary actors involved in knowledge reuse. These are producers (creators of knowledge), intermediaries (package and prepare the knowledge for storing, retrieval and sharing) and consumers (users of knowledge). Knowledge can be reused internally (use of producer's own knowledge), externally (use of consumer's knowledge), by common work producers (people working in team produces knowledge for themselves), by Shared work practitioners (people who does same work in different environments or location) and Expertise-seeker (people who seek out knowledge from experts (Fruchter and Demian 2002: 1-2).

The *knowledge sharing* is the most important KM process because it makes the right information available to right people. IT tools are used to share the information among users to get knowledge. The sharing of knowledge needs proper strategy for knowledge management, correct KM models, proper KM cycle for knowledge creation to sharing and a robust and efficient architecture to build IT portals who can handle this process.

KM in Organizations

The primary KM strategies are made when the company decides to enable and enhance the processes outlined earlier *(knowledge discovery, knowledge the organization, knowledge creation, knowledge sharing and knowledge reuse)* and to define which knowledge is relevant.

The primary KM strategies used in managing the organizations include *Management of The organizational Structures*, *Management of Knowledge Retention*, *Management of Core Competencies*, *Management of External Network*, and *Management of KMSs* (Botha et al. 2008).

The *management of the organizational structures* includes management of project teams, teamwork and other social functions. The organizational structures are of two types: formal and informal. The *formal* structure can interfere with KM if enforced. The informal structure is perceived as a community (Brown and Duguid 1991: 40-41).

Management can affect the organizational structure through the use of project teams, teamwork, and social functions. The choice of structure and the physical division of the firm is significant because it will affect knowledge flows. In practice, decentralized structures are more beneficial for KM (Choi and Lee 2000: 1-2, Claver-Cortés et al. 2007: 46-47, Chen and Huang 2007: 105-106).

The management of knowledge retention is concerned with making sure that important knowledge assets remain in the firm over time although key employees leave the firm. Formulation of a knowledge retention strategy depends upon understanding which knowledge is important. For knowledge retention, a firm may choose to implement one of many initiatives and tools, such as reward structures, mentoring, interviews, and utilizing knowledge from retirees (Liebowitz 2011: 1-3).

The management of core competencies follows four step process: identifying, sustaining, building, and unlearning. KM plays an important role in this process by identifying the knowledge and expertise of the firm, leveraging knowledge assets across the organization, building the right logic and expertise to match strategic requirements and removing or changing the obsolete knowledge (Pralahad and Hamel 1990: 77-78).

The management of external network incudes handling of external knowledge sources such as customers, suppliers, competitors, partners etc. KM plays a role in the assessment of important partners, by helping to determine what the organization knows, what is its needs, and the best ways of getting that knowledge. Management of external knowledge sources ensures that whether the right knowledge has been transferred and integrated into the organization or not. The general steps for management of external networks are: identification of potential target network, evaluation of target, establishing the relationship with target and knowledge integration. The management of external network are providing all relevant information related to internal knowledge assets, helping in evaluation process and encouraging knowledge integration and sharing (Botha et al. 2008).

The management of KMSs is helpful in sharing, discovering, and creating knowledge. Failures are generally happen due to over reliance on technology, a lack of understanding of the limitations of these systems, improper fit with the organizational practices or lack of acceptance of these systems. The proper implementation of KM needs attention paid to the organizational fit (internal assessment of needs and work practices, cost-benefit analysis), the organizational acceptance (by involvement of the

user in the design, implementation, managerial and technical support) and continuous use of KM practices (Gamble and Blackwell 2001: 68-71).

KM uses technologies from knowledge-based system design such as strategies related to structured knowledge acquisition from experts and educational technologies (McGrow and Harrison-Bridge 1999: 28-29; Gery 1991: 11-14). These technologies are enabled by knowledge management systems.

4.1.3 KM Models

The primary aspect of building an effective KMS is knowledge management. Several models have been proposed which represent a holistic approach to different aspects of knowledge management (people, process and technology). These models present a robust theoretical foundations of KM for explaining, describing and predicting the best way to manage KM. The most important KM models are:

A. The Spiral Model introduced by Nonaka and Takeuchi (Nonaka and Takeuchi 1995)

This KM model is an approach which deals with knowledge creation and management of innovation. The all forms of knowledge (tacit/explicit) and three tier of knowledge sharing (individual/group/the organizational) both are needed to create knowledge and innovation. This model deals with a well-defined knowledge creation process.

Knowledge creation process starts with individuals. Then the individual's private knowledge (predominantly tacit knowledge) is translated into valuable, public the organizational knowledge. Making personal knowledge available to everyone in the organization is the core principle of this KM model.

The engine of the knowledge creation is a four step knowledge conversion process between tacit and explicit knowledge. This four step process involves tacit to tacit (socialization), tacit to explicit (externalization), explicit to explicit (combination) and explicit to tacit (internalization).

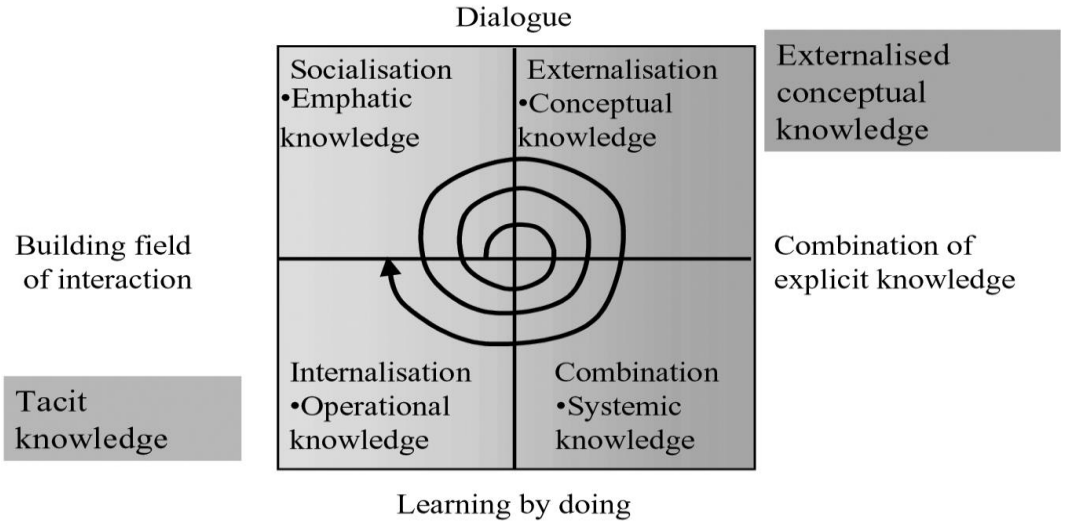

Figure 2. The Nonanka and Tekeuchi Spiral KM model (Nonaka and Takeuchi 1995).

In this model, the knowledge creation depends on continuous and dynamic interaction between tacit and explicit knowledge throughout all quadrants shown above. The organizations develop tools and models to gather and share knowledge. The knowledge spiral is a continuous activity of flow, sharing and conversion of knowledge by individuals, group and the organizations. In this model, the primary conditions for knowledge creation are a) Intention (goal of the organization), b) Autonomy (conditions in which individual act autonomously), c) Creative Chaos (conditions that stimulate interactions between the organization and the external environment which create fluctuations), d) Redundancy (existence of knowledge that goes beyond immediate requirements of the organizational members) and e) Requisite Variety (internal diversity to match the variety of the environment to provide everyone in the organization the fastest access to the variety of knowledge).

B. The Building and Using Knowledge Model by Wiig (Wiig 1993)

The Wiig KM model explains that the knowledge can be useful and valuable if it is organized. Generally knowledge is organized and stored in the form of semantic networks. To organize knowledge in the form of semantic networks Wiig's model suggest following dimensions: *completeness*, *connectedness*, *congruency*, *perspective* and *purpose*. *Completeness* answers the questions that how much useful information is available from a given source such as human minds or knowledge bases. *Connectedness* defines relationship between different knowledge objects. *Congruency*

explains that all the facts, values, judgments, association and relationship between knowledge objects are consistent. *Perspectives and Purpose* describes the knowledge and view of specific purpose.

The Wiig KM model describes three forms (personal, public and shared) and four types (factual, conceptual, expectational and methodological) of knowledge.

Public knowledge is explicit and routinely shared knowledge that is available in public domain. *Shared* knowledge is proprietary knowledge that are held by a group of knowledge workers and shared in their work. *Personal* knowledge is more tacit than explicit. It is most complete knowledge but least available in work.

Factual knowledge deals with data, facts, measurements and readings. *Conceptual* knowledge deals with systems, concepts and perspectives. *Expectational* knowledge deals with judgments, hypothesis and expectations. *Methodological* knowledge deals with logic, strategies and decision-making methods.

The three forms and four types of knowledge makes a KM model matrix which is called Wiig's KM Matrix which helps practitioners to have a refined approach to manage knowledge.

C.The KM Process Framework by Bukowitz and Williams (Bukowitz and Williams 1999)

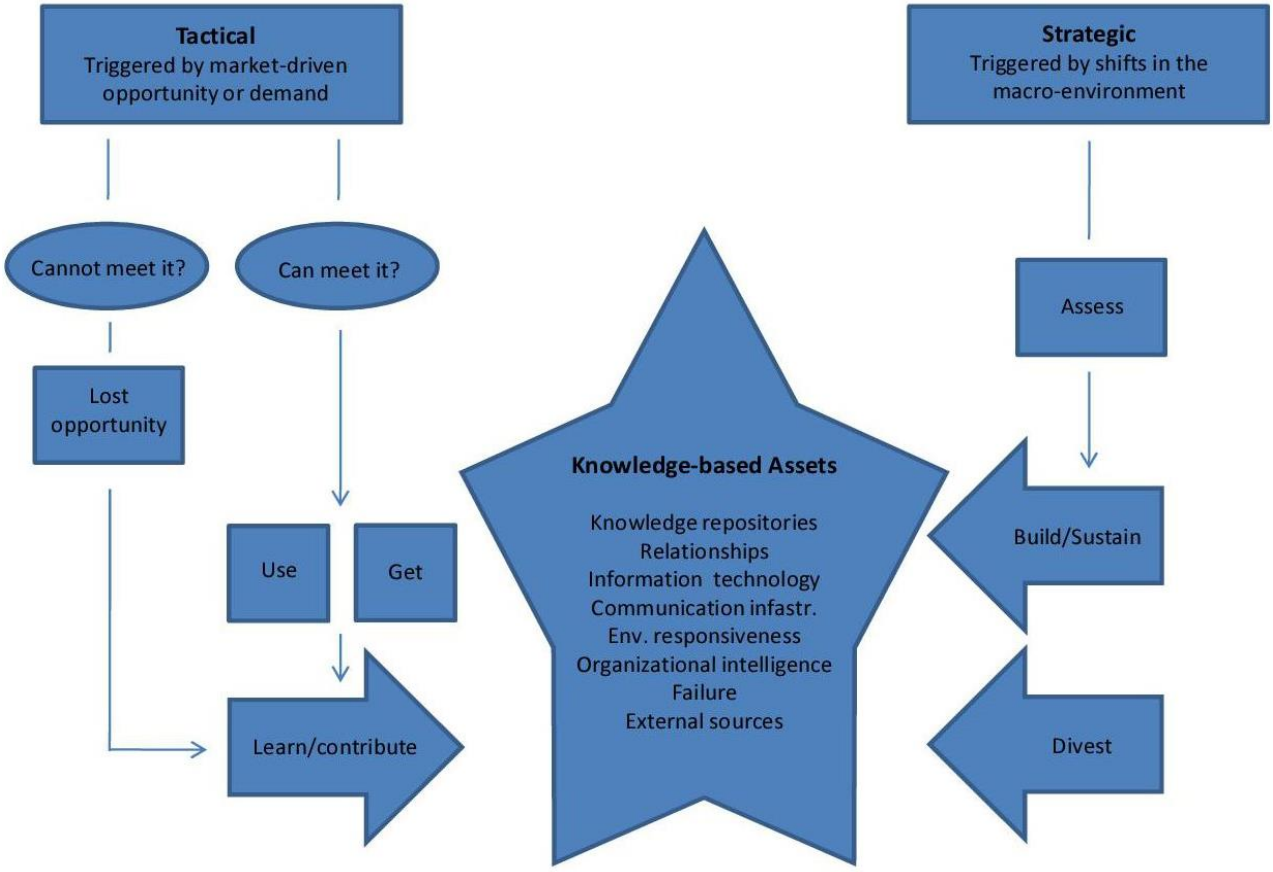

Figure 3. Bukowitz and Williams KM Process model (Bukowitz and Williams 1999).

This KM model depicts the process that defines the strategy for management to build, divest, and enhance knowledge assets. The strengths of this model rest on its strategic focus, which essentially puts knowledge management action into context. It is also important to note that the notion of "divestment" is included something which is often missing from KM models. KM initiatives are the result of the response to tactical and strategic changes and needs. The model provides a great overview of the strategy behind KM but it does not include any deeper insight into what initiatives are suitable in a given instance.

D.The Knowledge Management Model by Botha (Botha et al. 2008)

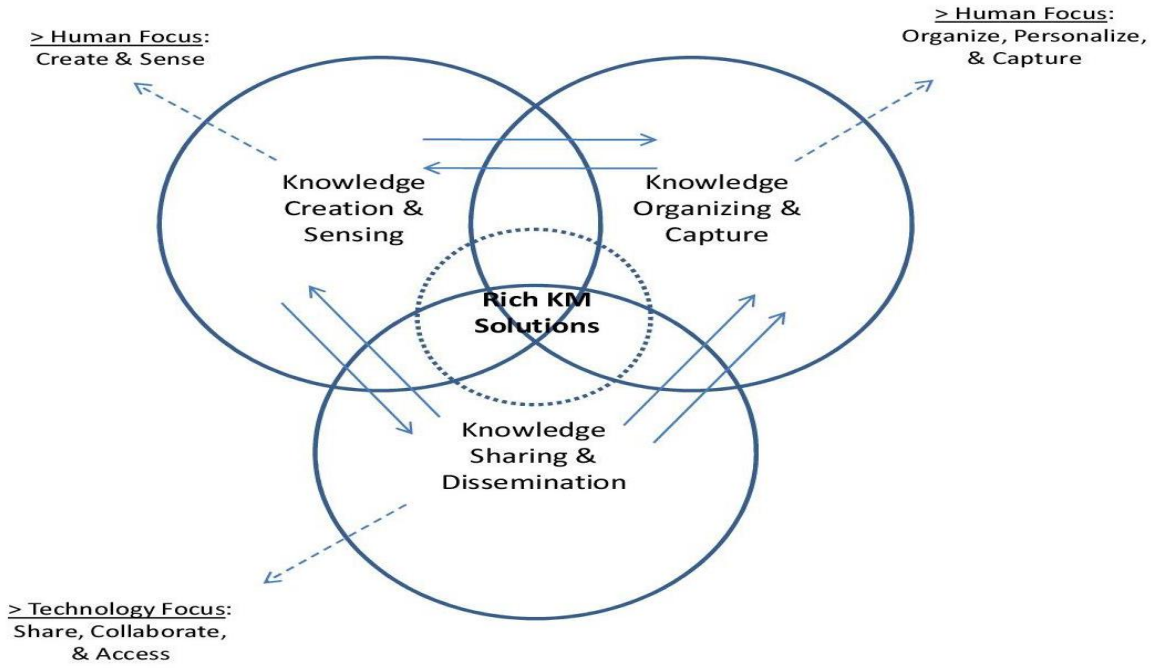

Figure 4. The KM Model by Botha (Botha et al. 2008).

The model presented in Figure 4 offers a realistic overview of the KM process. The three broad categories overlap and interact with one another. The model shows that those three categories are people oriented and technology focused. This model also includes the creation of new knowledge as a specific KM initiative.

4.1.4 KM Cycle

Another important aspect of KM is the cycle which explains the way knowledge is managed in a system. The knowledge can be managed in the form of explicit knowledge in different phases. The different phases of KM cycle are *creation*, *the organization and storage*, *sharing*, *access* and *use* (Dalkir 1995: 25-27).

The first step of KM cycle is *Creation* of knowledge. New knowledge is created or existing knowledge is gathered. A knowledge audit is a good technique for discovering what exists.

The second step is *the Organization and Storage* of knowledge. The knowledge is classified and stored, perhaps using a company specific taxonomy. This makes subsequent retrieval easier.

The third step is S*haring* of knowledge. Information may be 'pushed' to people as part of routine dissemination or it may be simply 'parked' in information repositories for individuals to access it when needed. For tacit knowledge, this part of the cycle involves knowledge transfer activities such as meetings.

The next step is proper *Access* to knowledge repositories. Individuals browse or search the organization's information and document repositories, typically via an intranet. Users 'pull' the information when they need it.

In the last step, the proper *Use* of knowledge is analyzed. They use this knowledge to carry out specific tasks. As they use it the knowledge is evaluated, refined and improved. As a result new knowledge is created and the cycle repeats.

4.2 Overview of KMS and Its Building Blocks

In general terms, KMS is a specific technology which is used for effective knowledge management. It refers to any type of IT portal that stores, retrieves, captures and uses knowledge, improves collaboration, finds sources of knowledge, mines repositories for hidden knowledge, or somehow enhances the KM process. In other words, it may refer to a combination of tools and platforms which is used to manage the organizational knowledge (Alavi and Leidner 2001: 26-28). The primary goal of KMS is to bring knowledge from the past to be used in present activities which results in an increased level of the organizational effectiveness (Lewin and Minton 1998: 515-516).

KMS has proved extremely useful in performing many of KM functions (for example, for content management and data mining, looking for hidden knowledge or relationships within contents). It is used to update, distribute, tag, and manage content. It may include a wide range of functions, including web-content management and document management systems. It can be used to import and create documents and multimedia material, identify key users and their roles, assign roles and responsibilities to different instances of content categories or types, define workflow tasks so that knowledge managers can be informed when changes in information are made, track and manage multiple versions of information, and publish information to a repository to support

access. KMS can also incorporate search and retrieval mechanism. The indexing, searching, and retrieval mechanisms of KMS (e.g. using meta-data or content from the actual document) and other mechanisms are used to facilitate KM process.

KMS is a technological part of person-oriented and the organization instruments called knowledge management *initiatives* which target the improvement in productivity of knowledge work (Maier 2004: 68-70). KM initiatives are classified according to the strategy of both human-related personalization and technology-related codification (Hansen, Nohria and Rierney 1999: 108-110). They are further distinguished according to the scope of initiatives related to enterprises and principles that cross the organizational boundaries. According to these principles, initiatives can establish a central unit for KM, or they can be run by a set of communities or projects. These initiatives generally focus on a specific type of content along with knowledge management life-cycle, for example, ideas, experience, lesson learned approved knowledge end product, procedure, best practices etc. Also the KM initiatives are also characterized by open, trustful or collective the organizational culture where willingness to share knowledge is high (Maier 2004: 98-100). Hence proper initiatives determine the right selection of KMS.

KMS is used to support and enhance knowledge intensive tasks, projects and processes related to knowledge creation, the organization, storage, retrieval, transfer, formatting, reuse and revision (Jennex and Olfmann 2003: 207-214). It can be said that KMS provides a pipeline for the smooth flow of explicit knowledge through a refinement process (Zack 1999). The focus on this refinement process is a user-centric approach which uses information technology (IT). This IT powered user-centric approach provides a base system to capture and distribute knowledge (Jennex and Olfmann 2003: 207-214). KMS is not an application system which targets a single KM initiative, but a platform which can be used either for supporting knowledge processes or for integrating base systems and repositories on which KM application systems are based. This platform offers functionalities for user administration, messaging, sharing of knowledge and conferencing. Other advanced services such as personalization, clustering and categorization to enhance the relevance of retrieved knowledge, advanced graphical techniques , shared workspaces, distributed services and integration of knowledge from various distributed sources (Maier 2004: 68-70).

KMS can be applied in a large number of application areas related to knowledge for creating and sharing good practices, implementing different experience-management

systems, organizing knowledge in proper taxonomy and ontology, managing competency, filtering and handling of interests that is used to connect people, developing knowledge networks and facilitating problem solving intelligently (Tsui 2003: 14-22).

KMS is primarily used to share explicit knowledge but can also help in communication used to interpret citations and generate activities, behavior and solutions. So KMS not only store knowledge but also share it among its users. It can also create, organize and reuse knowledge (Alvi and Leidner 2001: 112-114).

To take advantage of all of these functions, it is a well-known fact that the system should be chosen and implemented appropriately.

The building of a proper KMS in an organization is required for running an effective and efficient KM process. The building of KMS requires good the organizational and technological infrastructure which is effective in knowledge management. The primary infrastructure required for building KMS are: *The organizational culture, The organizational Structure, information technology infrastructure, Physical Environment and Some other Common Knowledge* (Bacera-Fernandez and Sabherwal 2010: 42-49).

The organizational culture depicts the norms and beliefs that discusses the behavior of member or the organization. A supporting the organization culture motivates employees to understand the benefits of KM and to find the way of KM. The enabling of the organization culture includes understanding the importance of KM practices, management support for KM, incentives to reward knowledge sharing and motivation of interaction among employees to create and share knowledge.

The organizational structure is also an important the organizational infrastructure required to build KMS. Several aspects of the organizational structure have been discussed. First, the hierarchical structure of the organization affects persons with whom individual frequently interacts for knowledge transfer. In traditional hierarchical relationship, the flow of data and knowledge is dependent of the nature of groups who make the decision. By decentralizing the organization structure, companies remove the organizational layers and put more responsibilities on individuals and increases the size of groups reporting to individuals. The knowledge sharing happens in a larger group. Second, the organizational structures facilitate KM through communities of practice (COP). COP is a self-organized group of geographically dispersed group of

individuals who communicate regularly and share knowledge. It becomes easy to communicate in large group by using COP than traditional hierarchical group. It also provides access to external knowledge sources, for example customers, suppliers and partners. Third, the organizational structure can also facilitate KM by specialized structures and roles. In this case, the organization specifically appoints individuals in different roles who generally help in handling knowledge by creation and sharing.

The organization's *information technology infrastructure* also helps in knowledge management. The information technology infrastructure includes data processing, storage and communication technological systems. It includes technologies related to data bases, data warehouses, enterprise resource planning etc. The capabilities of IT infrastructure provides KM in four different aspects: reach (access and connection to knowledge), depth (access to detail and amount of knowledge that can be effectively communicated), richness (provides multiple forms of knowledge, variety of knowledge) and aggregation (large volume of knowledge extracted from different sources).

Common Knowledge refers to the cumulative experience of the organization to understand knowledge, activities and organizing principles that is used in communication and coordination. It provides unity to the organization. It includes vocabulary, common language, shared rules and norms, common shared knowledge and individual knowledge domains. It increases the value of individual's knowledge by integrating with other's knowledge. This increase is specific to an organization and cannot be transferred to partners and competitors. So it supports knowledge transfer within the organization not outside the organization.

Physical Environment refers to the design of buildings of the organization; the location, size and types of offices; the nature of meeting rooms; and so on. It provides a physical space to employees to meet and share knowledge. It provides a space for both informal and formal knowledge sharing and ideas creation.

The building of KMS depends on the proper architecture and functionalities of KMS. The right combination of KM tools useful in building KMS is also of paramount importance. The KMS architecture describes the proper structuring of its different subsystems. The functionalities of KMS can also be described by the use of different subsections of the system. KM tools are foundational structures of building knowledge management system which is used to promote knowledge management. They use technologies and also involve some kind of structural or the organizational

arrangement modes of operation for KM. The primary role of tools and technologies is knowledge discovery, the organization, sharing and creation.

4.2.1 Types of KMS in Practice

The KMS system is designed for any the organization is dependent on its need. Broadly two types of architecture can be proposed to build an enterprise KMS. These are: *Centralized KMS* and *Peer-to-Peer* (p2p) KMS.

The *centralized KMS* architecture is based on the concept ofa central KM server which offers and integrates all knowledge services shared in an organization. The key services provided in this type architecture are *Data and knowledge services*, *Infrastructure services*, *Integration services*, *knowledge services*, *personalization services* and *access services* (Maier 2004: 11-17).

Data and Knowledge services of KMS provide data from internal sources (e.g. transaction processing systems, data bases, data warehouses, content management systems, personal information management systems) and external sources (e.g. Databases from data supply companies, internet) of the organization as source of knowledge.

The overview of a centralized KMS is shown in Figure 5 below.

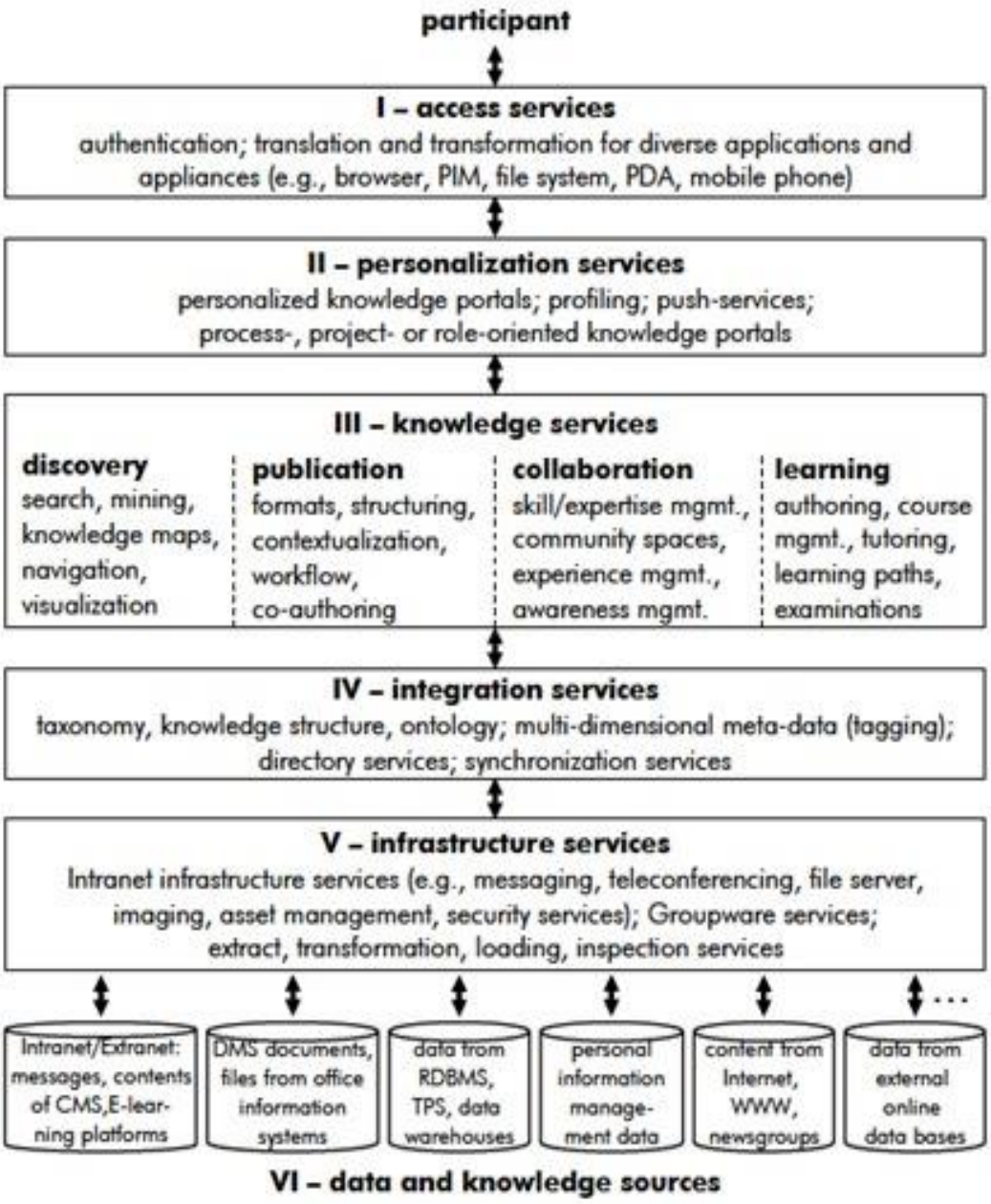

Figure 5. Centralized KMS.

Infrastructure services provide basic functionality for synchronous and asynchronous communication (e.g. sharing of data and documents, management of electronic assets and web content)

Integration services organize and link knowledge elements coming from various sources meaningfully in ontological and taxonomic fashion. The link between elements is also used to analyze the semantics of the organizational knowledge base. In other words it can be said that it is used to manage the meta-data of knowledge elements and knowledge workers using KMS.

Knowledge Services support the core processes of KMS such as discovery (search, retrieval, and presentation of knowledge elements and experts with techniques such as data mining, visualization, mapping etc.), publication (authoring, structuring, contextualization and release of knowledge elements supported by workflows), collaboration (joint creation, sharing and application of knowledge by both providers and seekers with tools such as contextualized communication tools, location management tools, experience management tools) and learning (supported by authoring tools, learning paths, examinations, course management).

Personalization Services provide a method of effective access to large amount of knowledge elements. Specialists or manager can make a portion of KMS contents and services for specific roles. The personalization of both portals and the services can be done with the help of techniques such as interest profiles, personal category nets etc.

Access Services allows user to access the KMS content with the help of different services that translate and transform the contents to and from KMS to heterogeneous applications. By using proper set of authentication and authorization tools, KMS content can be secured from eavesdropping and unauthorized use.

In case of *peer-to-peer* KMS architecture (P2P KMS), peer-to-peer metaphor has been used with KMS architecture (Parameswaran et al., 2001: 8-14; Maier and Sametinger, 2004: 9-13). The architecture of this KMS is also similar to centralized KMS only exception is with authentication or coordination mechanism. Every peer has client and server functionality associated with it. A peer is always connected with one single super-peer (server) which helps to make a cluster of peers. Sometimes super-peer are connected with each other results in formation of peer-to-peer network. Requests from one peer are handled by the connected super-peer and then it is forwarded to other super-peers. The level of layers are same for both centralized KMS and peer-to-peer KMS except few exceptions.

In case of P2P KMS, *Infrastructure services* handle loading of knowledge from personal knowledge sources and provides peer-to-peer infrastructure to locate other peers. *Integration services* handle meta-data of knowledge objects and create a personal taxonomy or ontology of objects in the knowledge base. The knowledge base is divided in three areas: private, protected and public. Private workspace contains information that can accessed by owner only. Public workspace contains information that can be published on internet and can be accessed by undefined set of users. Protected workspace is accessed by a group of users. *Knowledge services* build upon

knowledge base such as in centralized KMS case. In this case the knowledge repository is dispersed among peers that have been granted access to a part of repositories. *Personalization services* is built upon user profiles and centralized personalization services provided by the super-peer. The case of *Access services* is similar to that of centralized KMS.

In case of super-peer (server), *Infrastructure Services* access shared data and knowledge sources and helps the peers with additional services. It also provide services for lookup and message handling that improves efficiency of p2p KMS. *Integration services* offers a shared taxonomic or ontological design for the domain being handled e.g, by a network of subject experts. The super-peer offers a replication service to its peers which solve the problem related to the integration of knowledge bases of P2P KMS. *Knowledge services* is similar to that of centralized KMS having no central services in addition to peer services. *Personalization services* make easy access to the organized collection of quality knowledge for example, profiles and push services. *Access services* are related to the administration of centralized knowledge server and the personalization profiles.

The peer-to-peer removes many problems associated with centralized KMS, such as reducing the cost associated with the design of centralized knowledge server, reduces the barriers of knowledge workers to participate and share content actively, to overcome the limitations associated with focus on internal knowledge of the organization by allowing to cross the organizational boundaries, to include instant messaging systems such as e-mails into knowledge work system and to integrate the shared knowledge workspace with knowledge workers personal workspace.

But the biggest problem in implementing P2P KMS is the lack of proper access management and high cost. That is why most the organizations prefer a centralized KMS.

4.2.2 Architecture of KMS

The design of a fully function enterprise KMS is recommended to be composed of seven layers integrated with each other (Tiwana A 2001: 274-312). These seven layers provide a guideline for the selection of right technologies that will help in effective sharing of knowledge across the enterprise. The functionality of these seven layers are illustrated in Figure 6 below.

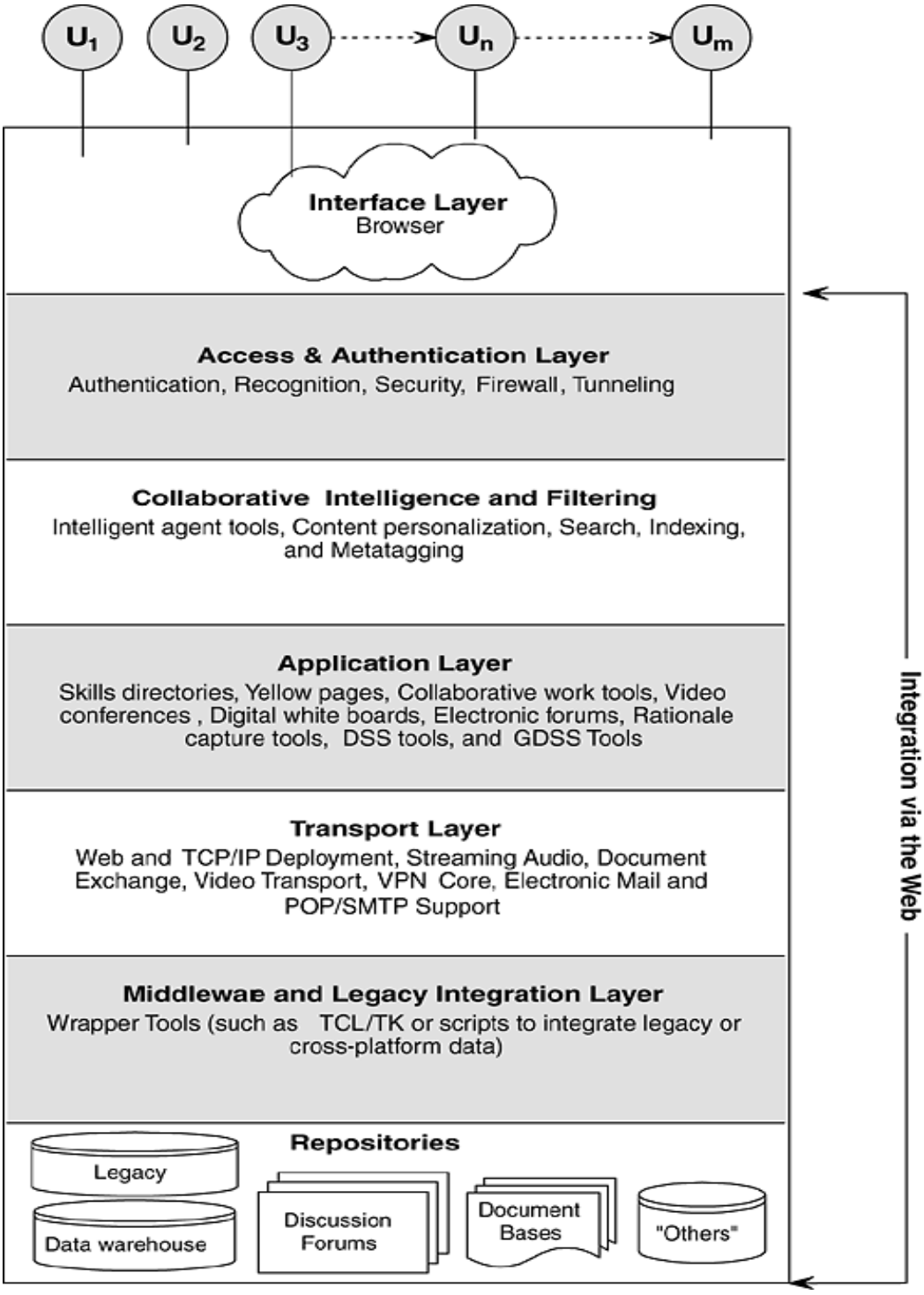

Figure 6. Overview of KMS architecture.

As shown in Figure 6, *Interface Layer* is the topmost layer of KMS. This is the point where users interact with KMS. This can be easily built with an internet development tools and then customized according to users. This is the place from where content enters and leaves, hence it should be optimized to handle unconventional traffic such as audio, video contents. This interface should be independent of platform.

Access and Authentication layer is the layer where security mechanism is implemented. The security mechanism is implemented to secure KMS and raw data. This interface allows authorized users to use the system.

Collaboration Intelligence and Filtering Layer: The KMS intelligence lies in collaborative filtering which is associated with this layer. This layer helps in transforming KMS from client/server to agent/computing model. This layer has implementation of intelligent algorithms to do most of the automated tasks such as filtering, tagging, navigation, subscription etc.

Application Layer handles applications such as directories, yellow pages, video-conferencing software, collaboration software, decision support tools. The applications of this layer should have functions and processes supporting KMS.

Transport Layer should be in operation when KMS is using network. This layers have components: TCP/IP connectivity throughout the organization, running webserver, running mail server, virtual private networks, and support for streaming unconventional files, such as video and audio files.

Middleware and Legacy Integration Layer provides connections between legacy data and new or existing systems and old and new data formats. Many tools and scripting languages can be used to build this layer.

Data Repositories is the bottom layer of KMS architecture. This layer consists of operational databases, discussion databases, web content archives, legacy data, digital contents, object repositories etc. The repositories are integrated with contextual information and sometimes tacit knowledge.

4.2.3 Features of KMS

The selection and classification of technologies depends on their use. The technologies can be used in knowledge creation, codification and transfer. The features of KMS are defined on the basis of use of technologies needed for building KMS. The features of KMS can be defined as *Communication*, *Collaboration*, *Content Creation*, *Content Management*, *Adaptation*, *Networking* and *Artificial Intelligence* (Rollet 2003: 23-31).

Communication can be done by e-mail, chat, video conferencing. Many IT tools are available for this purpose, e.g. outlook, chat rooms, forums and video chat rooms. KMS facilitates a single access point from where people can interact with other people based on need instantly. E-mails can be used for sending mails, chat rooms offer a platform for instant and informal chat, forum can be used for discussion on certain topics and video conferencing can used for video conversation.

Collaboration includes works such as group calendaring, workflow, groupware services. The collaboration may be synchronous or asynchronous. They may be collocated or at different locations. In this purpose different types of tools are used. Such as in case of synchronous collaboration people can use presentation, documents for collaborative writings, wikis for open editing on website etc. In case of asynchronous collaboration, shared data or knowledge repositories can be used. People can use chat or video if they are working collocated. When people are distant they can use e-mails for this purpose. Group calendars allows scheduling, project management and coordination among people.

Content Creation includes creation of content in web format or documents. Most common content creation tools are authoring tools. Most commonly tools in this aspect are word processing, web page design software, wikis and blogs for sharing and publishing contents on specific topic. Annotation techniques can be used to make short comments to specific sections of the document. The document can be created and stored in version that helps in easy tracking of documents and contents.

Content management is done to manage valuable content throughout the life-span of the content. It generally begins with content creation and handles multiple changes, updates, merging, summarizing, repackaging and archiving. Metadata can be used to manage the content in a better way. Tagging can be used to tag knowledge content. Taxonomy is used to organize and classify the content in a better way for easier retrieval and use. For this purpose predominantly content management systems (CMS)

are used. CMS can be either proprietary CMS, e.g. Documentum, or open source CMS, e.g. Alfresco, Plone, Joomla. CMS can display contents on web in proper format.

Adaptation technologies are used to arrange content for a specific group of users who have common need. The arrangement of knowledge can be done by either *customization* or *personalization*. In *customization*, knowledge workers can change their environment based on their preferences. In *Personalization*, the content and interfaces are automatically changed based on observed and analyzed behavior of users. Based on profile of users, the personalization can be done by recommending few services or contents. The recommendation can be done also on similarity analysis of users having same interest. The tools in this case generally reorder or put items at one place based on the interest or desire of users.

Networking tools are intranets, extranets, knowledge repositories, knowledge portals and web-based shared workspaces. These tools are used to share contents inside the organization or within the organizations for specific use. The knowledge repositories can be used to contain information related to concepts, definitions, assumptions, processes, events, actions, rationale for decisions, and circumstances for decision. Knowledge portals provide access to diverse enterprise content, groups, expertise, different internal and external services and knowledge base. The knowledge portals store and share contents through a taxonomy (Collins 2003; Firestone 2003).

Artificial Intelligence is related to the feature of KMS which assist users to use the system in an intelligent manner. Sometimes the system should work on behalf of users. The system should be intelligent enough to help users in newsgathering, content search and content filtering. The intelligent system should have features, such as autonomous, the ability to interact with other software easily, responsive to change of environment, personalized to need of users, proactive, adaptive and should improve with experiences and easy usability (Khoo, Tor and Lee 1998: 46-47). These applications can be used as watcher agents (looking for specific information), learning agents (personalize to users preferences by learning from users past behavior), shopping agents, information retrieval agents and helper agents (perform tasks without external interferences).

4.2.4 KM Tools Used in Building KMS

The tools used in building knowledge management system are *Groupware Tools*, *Networking Tools*, *Data Warehousing Tools*, *Decision Support Systems*, *Content Management Systems*, *Document Management Systems* and *Artificial Intelligence Tools* (Dalkir 2005: 115-126).

Groupware is term related to the specific set of technologies helps people to work collaboratively. The prominent type of groupware tools are communication tools (tools for sending messages and files such as e-mails, wikis, file sharing), conferencing tools (video/audio conferencing, chat, forums) and collaborative management tools (tools for managing group activities such as workflow systems, information management systems, project management systems). If implemented successfully, groupware systems are very useful in sharing explicit knowledge through publishing and communication tools and knowledge creation through collaborative management tools. The sharing of tacit knowledge can be done by conferencing tools and the recording of conferences can be stored for future use. Many applications are used for this purpose, for e.g. LotusNotes, SharePoint, Web 2.0 (Enterprise 2.0 or KM 2.0). The web 2.0 has become an effective tools for two way communications on the internet. This tools include blogs, wikis, social bookmarking, commenting, shared workspaces etc (Bebensee et al. 2010: 3-7). The application of web 2.0 within the organizations is called as Enterprise 2.0 and its mapping to KM is KM 2.0.

The most prominent *networking tools* are intranet and extranet. The intranet is a small scale version of the internet used within the organization for connection between different operating systems. The extranet is an extension of the intranet to the firm's external network such as partners, suppliers etc. The intranet and extranet can be used in knowledge sharing, collaboration, publishing (homepages, newsletters, employee directories), searching documents and contents (search engine, system of categorization), transaction (transactions with other web sites), interaction (interaction with other groupware, expert finders) and recording (storage medium for procedures, best practices, FAQ) (Newell et al. 2000: 1-17).

Data warehousing in knowledge management is related to actions such as warehousing data, mining data, online analytical processing and data visualization. Data warehousing is storing data in a centralized system to have the means to present them in the form of sound information and knowledge. It contains information ranging from measurements of performance to competitive intelligence (Tanler 1997: 67-75).

Data mining techniques used for the mission critical applications to filter, extract or transform datasets into summarized information and to explore hidden patterns in knowledge discovery. The data mining is a six-step process (Karahoca and Ponce 2009: 55):

Business understanding > Data understanding > Data preparation > Modeling > Evaluation > Deployment

Online analytical processing (OLAP) tools performs these functions: query and reporting (formulate queries without using database programming language), multidimensional analysis (carrying out analyses from multiple perspectives), statistical analysis (reducing large quantity of data into formulas that shows the answer of query).

The data visualization is presentation of information is presented graphically. The information can be presented as graphical interfaces, tables, images, graphs and animation.

The role of *Decision Support systems* is to access and manipulate data. They work with data warehouses, use OLAP tools and employ data mining techniques. The primary goal of this system is to improve decision-making and solve the problem with the manager. Decision support systems enhance the knowledge of manager through knowledge discovery and providing relevant information. Hence an effective decision support system is highly useful in knowledge management (Liebowitz 1999: 15-18).

Content management systems (CMS) are very relevant to knowledge management. CMSs are used for creation, management and distribution of contents over internet. The efficient CMS should provide templates for publishing, option for tagging content with metadata, option for easy editing, version control mechanism, easy collaboration during work on content, an integrated document management systems, workflow management and an extension for plug-ins for third-party software. An efficient CMS can be selected on the basis of technology (static and dynamic publishing of content, high performance, security and efficient search engine), ease of usability (the interfaces should be easy to use keeping in mind that most users are non-technical), low maintenance cost, cross platform support, scalable and web presence management (Sahu 2007: 1-5)

Document management system can be used in publishing, storing, indexing, and retrieving the relevant documents. These activities are done with explicit knowledge.

This type of management system is very useful in case of large amount of documents. The most important functions of document management systems can be capturing the knowledge, classifying the knowledge using metadata, indexing the knowledge, searching and retrieving the knowledge and keeping track of different versions of documents. The use of document management systems reduces operational costs and improves the efficiency and speed of retrieval.

The *artificial intelligent tools* are predominantly intelligent filtering tools and intelligent information gathering tools. Intelligent filtering tools such as search engine, are mostly used in case of filtering e-mails, news and documents. Intelligent information gathering tools (e.g. search engine collecting search history) collect the information about users and their activities to be used in other activities such as filtering of information. That's why the intelligent tools have become as important as the content (Wingfield 1995). Many intelligent tools can be used for looking for specific information (watcher agents), setting the content by learning user's past activities (learning agent), searching the best price for user (shopper agents), helping users to search most relevant content (information retrieval agents) and helping users to perform tasks efficiently (helper agents).

4.2.5 KMS Building Cycle

The KMS building cycle follows an incremental developmental cycle. KMS should be helpful in creating, organizing, storing, sharing and reusing knowledge. The KMS building cycle depends upon key features such as the organizational norms, technologies, external knowledge from partners and customers. Based on the above-mentioned key features the decision networks of key personnel designs a blueprint of KMS. The KMS building cycle is shown in Figure 7 below.

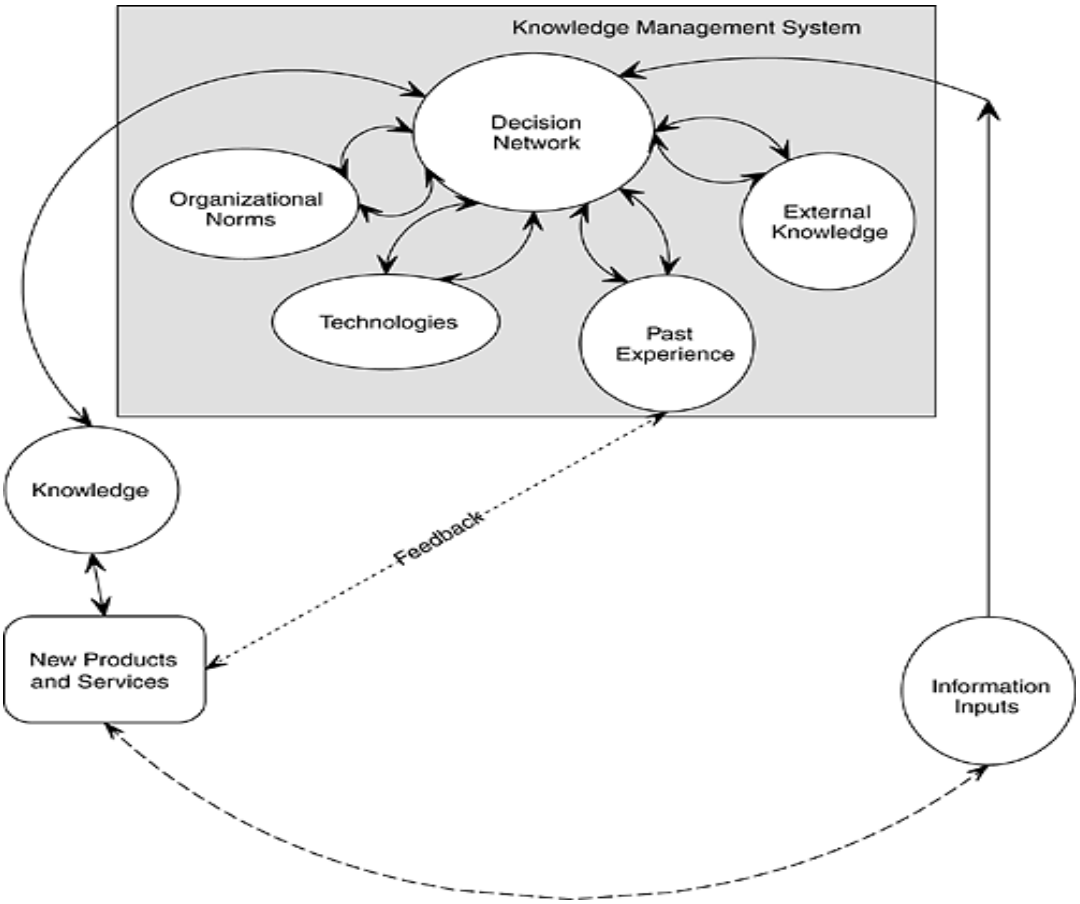

Figure 7. An Incremental Developmental Cycle for Building KMS.

Figure 7 shows the way of building a KMS using the draft of the architecture and various tools. The KMS cycle depends on the organizational norms, experiences of using previous KMSs, knowledge from consultants and customers, and various available technologies. The KMS performance is evaluated by users and based on their feedback and changes are made to KMS. Figure 7 also shows how the company can transform information into new services by using knowledge, past experiences and technologies (Tiwana A 2002: 115).

4.3 Conceptual Frameworks of This Study

Based on existing literature reported above, the conceptual framework for the case company suggests a framework for building a KMS which should manage knowledge efficiently. This KMS framework incorporates various types of KM models to manage knowledge. Primarily, KMS addresses the management of explicit knowledge. The

management of knowledge follows a particular cycle. The phases of this cycle are: *creation*, *the organization*, *storage*, *sharing* and *use*. In this regard, various methods have been proposed to design a KMS. The most prominent methods are technology-focused and human-focused. The human focus is related to creating, sensing, organizing, personalizing and capturing knowledge. The technology focus is related to sharing, collaborating and accessing knowledge made available by using advanced IT technology. The current study is related to sharing and accessing knowledge, hence the focus of study is technology. In this case, one of the central questions of knowledge managements, namely the conversion of tacit knowledge into explicit knowledge or vice-versa is not an issue.

The technology-focused KM model of KMS suggests concentrating on architecture, features and KM tools as main building blocks of KMS. In this case, the case company desires a centralized KMS. Figure 5 earlier recommended such type of the architecture for that purpose. According to the latest recommendations from the business practice and research literature, a KMS for an organization should have a seven-layer architecture described in Figure 9. Best practice also suggests that KMS should be built incrementally as illustrated by the development cycle Figure 7.

The cycle used in building of a KMS shown in Figure 7 is an incremental developmental cycle. This cycle uses the organizational norms, technologies, knowledge from partners and customers as the building blocks of KMS. Past experience in use of the previous systems in the form of feedback and knowledge from different stakeholders can also be used to improve the design and development of the new KMS. Figure 7 shows that how company can transform information into new services by using knowledge, past experiences and technologies.

This study, thus, concentrated on these three important aspects in designing a KMS: architecture, features and KM tools. Figure 8 presents a view illustrating the approach utilized in this study.

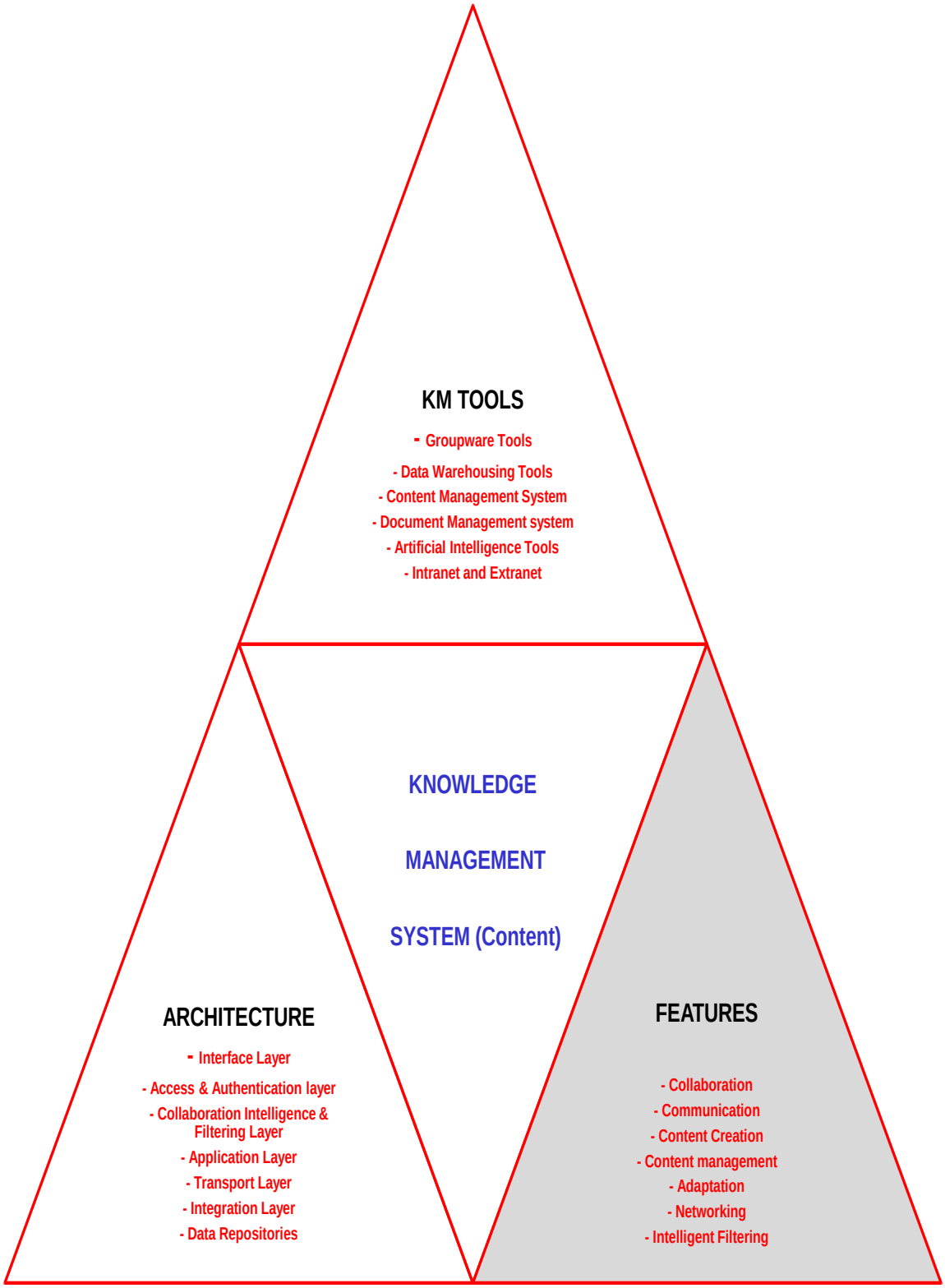

Figure 8. A conceptual framework for building KMS for the case company.

Figure 8 suggests a seven-layer centralized architecture of KMS (following Figure 6). The tabular view on the layers suggested for the KMS is presented below, with the use of the layers being explained (Tiwana A 2002).

Table 6. An overview of KMS architecture.

Multilayer Architecture of KMS	**Use of the specific layer**
Interface layer	Point of contact of KMS with users, access point of data in and out of KMS
Access and Authentication layer	Handles authorization of users, firewalls, blocks unauthorized users to access the content
Collaboration intelligence and filtering layer	Personalization of content and efficient search and browse retrieval mechanism
Application layer	This layer contains application related to directories, grouping, community, expert's data bases
Transport Layer	Deals with networking, connectivity, internet
Middleware and legacy integration layer	Wrapper tools, such as scripts which links data bases with various applications and other layer
Data Repositories	Information are stored in data bases and repositories

As advised by Rollet (2003: 23-31), KMS should be designed for communication, collaboration, content creation and content management, document management, data warehousing, personalized content presentation and intelligent filtering.

Table 7. KMS features and their explanation.

Feature of KMS	**Explanation of features**
Communication	For communication with people by suing several tools such as e-mail, chat
Collaboration	Collaboration with people in project execution using tools such as wikis, blogs
Content creation	Related to creation and storage of information wither in the web format or in documents
Content Management	Storing and sharing of content with users
Adaptation	Personalization of content based on preferences of users or on the basis of user's activities on the system
Networking	Used to connect with others or a group of people by using internet
Data Warehousing	Data storage system such as databases

Intelligent filtering	Search and browsing of information using intelligent mechanism or tools

The tools used in building KMS incorporates several features which are summarized in Table 8 below (Dalkir 2005).

Table 8. KM Tools, their functionalities and examples of tools.

KM tools	**Handling KMS features**	**Examples**
Groupware Tools	Collaboration, conferencing, communication	Wikis, blogs, e-mails, chat, forums
Intranet and Extranet	Networking	Internet
Data Warehousing Tools	Extracting data from databases to find hidden patterns in it	Queries to data base
Decision Support Systems	Helps people to apply appropriate techniques for relevant knowledge	Online help, tutorials, glossary, references, manuals
Content Management Systems	Content creation, indexing, storing, sharing, metadata tagging	Open source CMS and proprietary CMS, such as plone, documentum, joomla
Document Management Systems	Storing document and its version	Knowledge databases
Artificial Intelligence tools	Personalized content (adaptation), intelligent filtering	Content filter, Adaptation filter

Table 8 presents an overview of architecture, functionalities of different subsystem and KM tools used to build a KMS. The details of architecture, functionalities and usage of KM tools have been explained in Tables 6-8. The building KMS is dependent on its proper architecture. Designing a KMS needs properly defined functionalities of its subsystem. The KM tools which is going to be a part of system should have proper clarification. The proper understanding of architecture, functionalities of subsystem and KM tools can help in designing the system.

5 Building the Road Map for the New Knowledge Management System

This section overviews the development process of the proposal for the KMS for the case company. It presents the initial requirements from the case company and reports on the results of the evaluation and validation session, and presents the final proposal for the case company KMS.

5.1 Summary of the Initial Case Company Requirements for Building the Knowledge Management System

In previous sections which discussed the current state analysis and conceptual framework, the need of the case company was formulated as that of building a centralized KMS to store and share content with customers. This system is meant to run the projects smoothly and find the content efficiently, which would save a lot of time and effort. Apart from sharing content, the system can also be useful in creating, storing and reusing information.

The need of customers and project members is a KMS that can provide them the content in proper taxonomy and ontology. It can also provide a platform which will be used to contact experts and seek their advice on specific subject matter. The system should be useful in managing the contents and documents. It should also provide an efficient search mechanism which can help them to search content efficiently. It can help customers and users to save their efforts and time.

The case company needs a centralized multi-layer KMS. In literature, the best available centralized KMS can have a seven-layer architecture. The seven-layer can be interface layer, access and authentication layer, collaboration intelligent and filtering layer, application layer, transport layer, middleware and legacy integration layer and data repositories layer. This architecture was shown earlier in Figure 6. This KMS can be used for various purposes such as communication (used in e-mails, chats), collaboration (group calendaring, workflow, groupware services), content creation (words, wikis, blogs, forums), content management (updates, merging, summarizing, archiving, taxonomy and ontology of contents), adaptation (customization, personalization), networking (intranet, extranet, internet) and artificial intelligence (intelligent information search and retrieval, personalization of contents for users by their activities). The KM tools used in building such a KMS can be groupware tools (for

conferencing, collaborative and communication), intranet and extranet (for sharing contents), data warehouse tools (looking for hidden patterns in knowledge), data mining tools (extract valuable information from knowledge warehouse), decision support systems tools (improve decision making), content management system (creation, management and distribution of content), document management system (publishing, storing, indexing and retrieval of documents) and intelligent filtering tools.

The conceptual framework in this study was designed based on the information available in literature and the relevant needs of the case company revealed in the current state analysis. Thus, the researcher started the development process with a suggestion of the seven-layer architecture the case company. His suggestions were corrected and validated in the subsequent session for the conceptual framework evaluation. The results of this session are discussed in the subsequent section.

5.2 Evaluation of the Conceptual Framework for KMS Development

The conceptual framework of this study was evaluated by the same group of people listed in Table 1. The conceptual framework was presented to them as a starting point of the development process of the KMS for the case company. The respondents expressed mixed views about the different building blocks of the suggested KMS framework, as well as its seven-layer architecture. They were satisfied with the list of functionalities, except for a few exceptions. They also had similar views on the findings from literature about possible KM tools. Their views about the architecture, functionalities and KM tools are summarized in Appendices 5-7.

The key personnel proposed a five-layer architecture which was composed of the Interface layer, Access and Authentication Layer, Intelligent Filtering layer, Integration Layer and Data Repositories, along with some other third party applications. The new architecture was proposed on the basis of using many available cloud services and easily deployable applications. In that scenario, building Application Layer and Transport Layer separately does not make much sense. This new architecture makes a KMS flexible, and the applications and data repositories can be attached and removed without any obstacles. Hence the new five-layer architecture was approved as a suitable option for building the KMS for the case company.

This new vision of the KMS framework is presented in Figure 9 below.

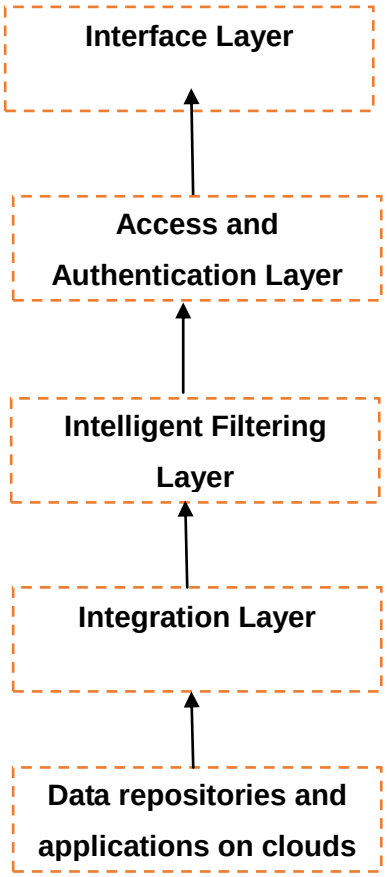

Figure 9. A five-layer architecture of KMS proposed by for the case company.

Table 9 present an overview of the required functionalities of sub-systems of the planned KMS. All participants agreed that the technologies related to communication, collaboration, data warehousing, networking and adaptation should be incorporated into the system.. The participants proposed only one exception to the findings from literature, namely the Intelligent Filtering. They suggested that, since KMS is built for the case company and needs a smaller scale, it would be enough to have intelligent filtering mechanism only. It also should not have search options for the past searching activities. In case of functionalities of different sub-system of KMS, the respondents had a similar view as suggested in the conceptual framework.

In this evaluation session, it was agreed that the technologies used for building KMS for the case company should be similar to those found from the literature. The list of tools and their use agreed in the evaluation session is summarized in Table 8 below.

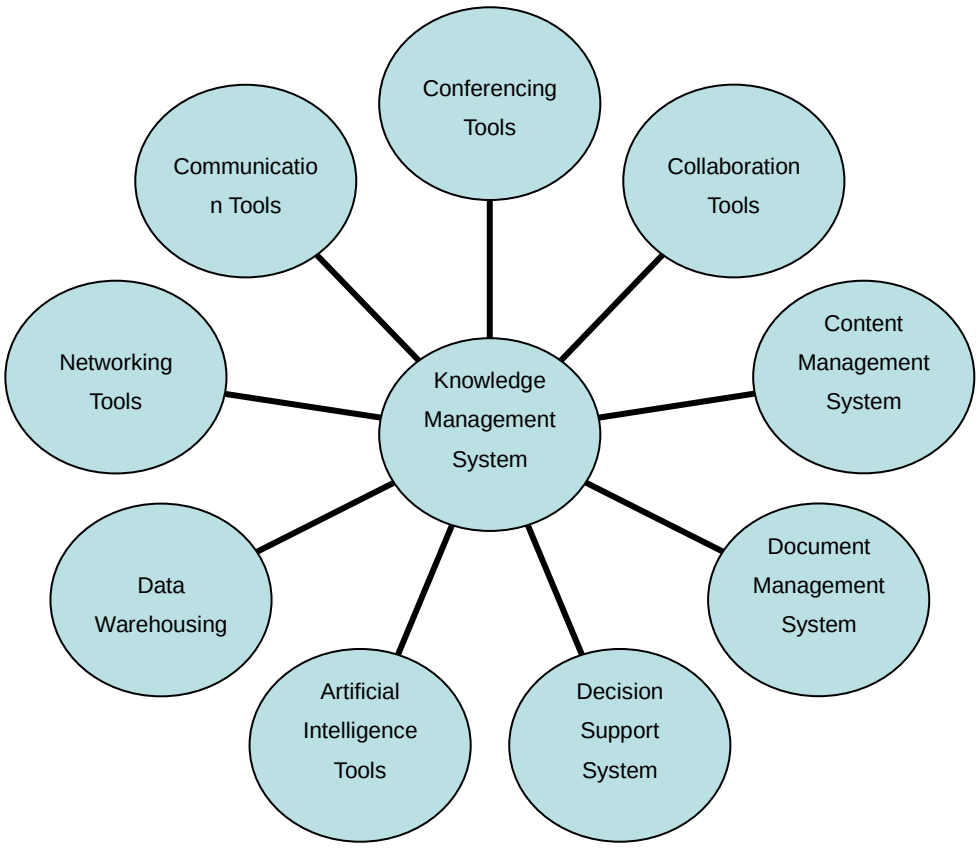

Figure 10. An integrated View of Knowledge Management System.

Figure 10 shows the selection of tools to be combined in the proposed KMS for the use by the case company, as agreed in the evaluation session.

Based on the evaluation session, the proposal for the architecture of the KMS for the case company was developed.-

5.3 Proposal for the Knowledge Management System for the Case Company

KMS desired by the case company has technology-focused orientation. The KMS developed for the case contains the following features:

Purpose: KMS should be used for collaboration, communication, content management, content creation, intelligent search and browse retrieval and data warehousing.

Technology Architecture: the design of KMS should integrate these tools properly. The architecture for such a KMS can be illustrated by Figure 11. This is a five-layer

architecture: *Interface Layer, Access and Authentication Layer, Intelligent Filtering Layer, Integration Layer and Data Repositories.*

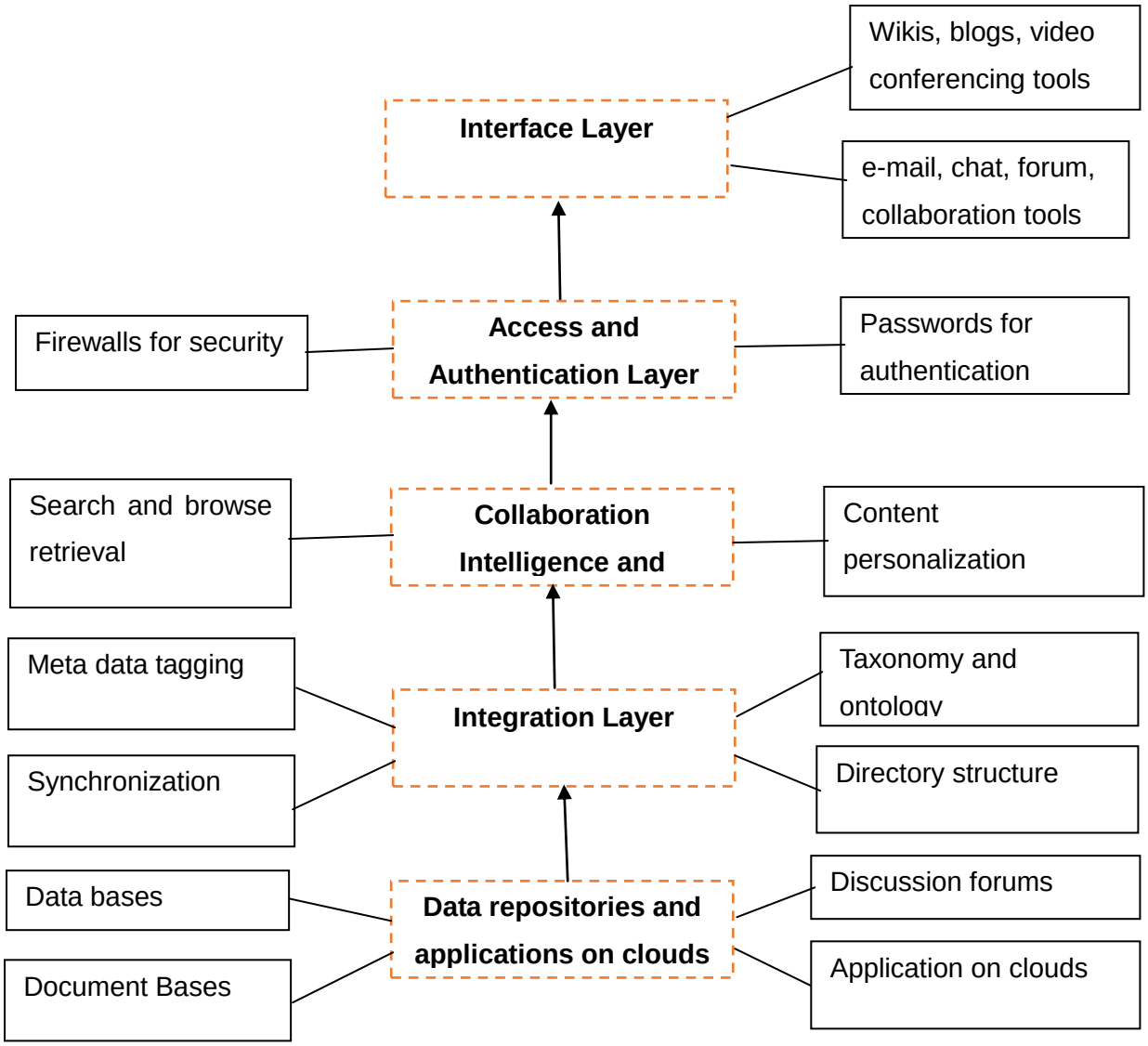

Figure 11. Functionalities of different layers of KMS architecture.

The most important layer is the *Interface Layer*. This is the layer where users interact with KMS. In this layer, information is organized and presented in a coherent form. In this study, the information and documents will be presented using icons, trees, personalized navigation, personalized directory and graphic design. This layer presents a window to the universal view of the organization, products, services and customers. The proposal for building this layer is using Web 2.0 technology. The content can be displayed on the web-browser. The menus, icons and buttons should have same meaning. All information should be consistent in the layout across all parts of KMS.

The information displayed should be relevant to users' expectations. Most of the information should be presented on a single screen. The information belonging to a particular section or group can be presented using a directory structure or pull-down menus. The color, margins and text-density should be used properly, which will add clarity to the content. The user should be able to navigate the system easily, and they could be able to navigate different packages or tools in a single mode of operation. The use of icons, menus and buttons should be easy. The user should be able to navigate files and databases with ease and speed.

The second layer is *Access and Authentication Layer*. This layer will maintain the security and only allow those users to access KMS who are authorized to use it. This layer will use protocols such as passwords authentication mechanism to make sure that right people should have access to the right content, and software tools such as firewalls to make sure that only the authorized person will have access to the content. Firewalls will stop intruders form getting information from the repositories. In this case, network administrator will play an important role in assigning the access rights to users. This layer should also contain backups which will be used in case of damage to content.

The *Collaborative Intelligence and Filtering Layer* will provide a customized view of content and an efficient search mechanism which reduces the time and effort of users. The view of authorized users can be tailored based on their preferences and uses. The intelligent system based on efficient algorithm can be integrated with KMS for efficient search mechanism. Many algorithms, such as case-based reasoning, machine learning approaches can be used for this purpose.

The Integration Layer can be used to integrate different tools. These can synchronize their data format. This is also used to integrate different data repositories and cloud–based applications with filtering mechanisms and access and authentication mechanism.

The *data repositories* contain different data bases (RDMNS and virtual data warehouses) and cloud-based applications. This layer contains valuable information which is shared with users.

KM Tools: the tools used in building this KMS for the case company should be *collaborative tools* (wikis, blogs, forum), *communication tools* (e-mails, chat), *conferencing tools* (audio, video conferencing), *networking tools* (intranet, extranet),

data warehousing tools (databases, data extraction tools from databases), *content management tools* (CMS such as plone, documentum), *document management tools* (data repositories, data versioning system) and *intelligent filtering tools* (adaptation filter and content filter). These tools should be integrated in such a way that it should present contents in a coherent manner. The contents available on the system can be easily tracked and used.

Figure 12 presents a summarized view of technologies used for building the KMS for the case company.

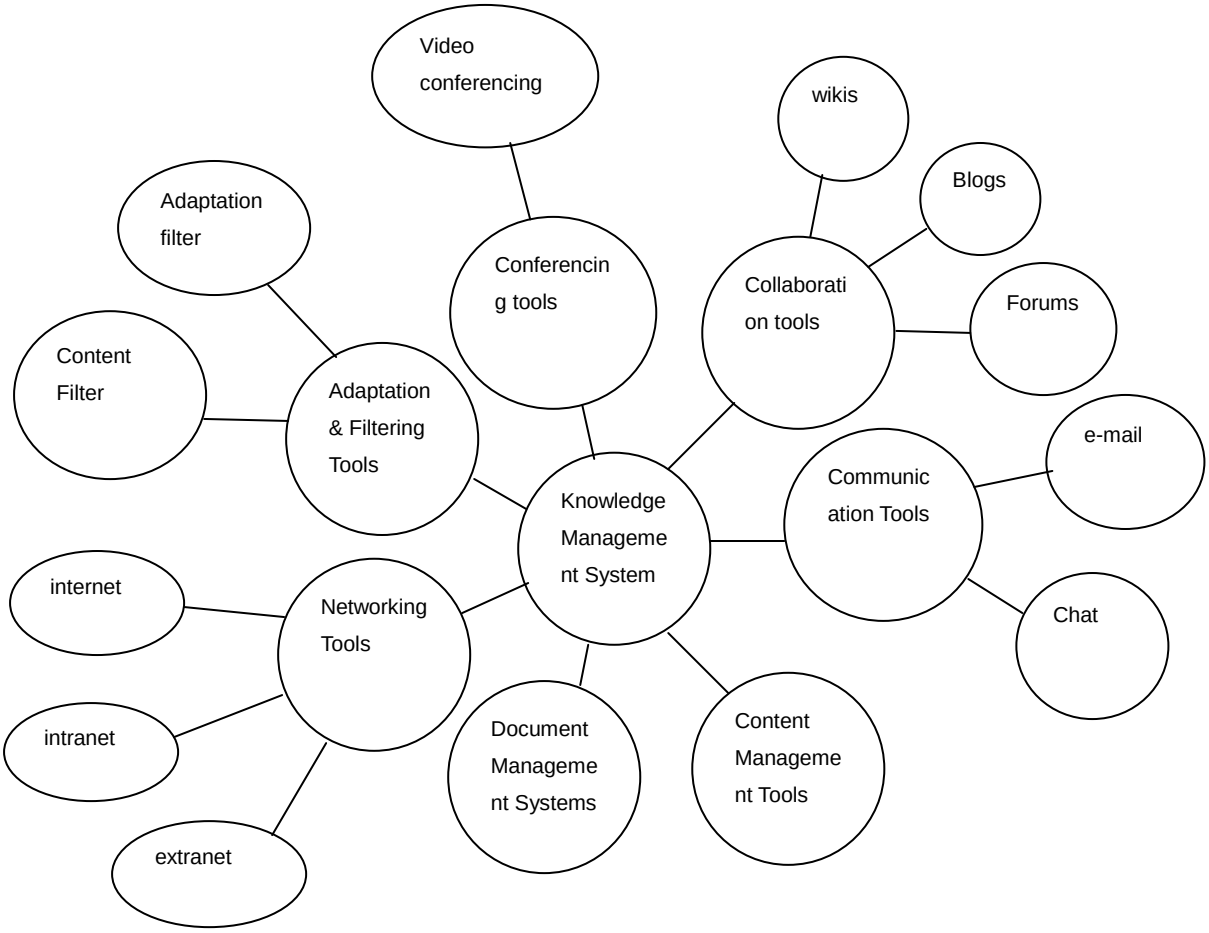

Figure 12. Overview of tools used for building the KMS for the case company.

The communication tools shown in Figure 12 are intended to be used for communication between different people or groups. It can be done by e-mail and chat. It is a useful tool in KMS which offers connectivity between people at will. The effect of communication tools can be enhanced by the availability of conferencing tool, primarily for video conferencing. Users and experts can also collaborate with each other by sharing contents on wikis, blogs or forums. The content can be created, stored,

indexed and shared by content management systems. People can store and make backup of documents in document management systems. The filters, such as adaptation filter and content filter can be used for several purposes. The adaptation filter can be used in personalization of content. The content filter can be used to search content and documents. The content and documents in KMS can be shared by respective ways using networking tools, such as intranet or extranet. The functionalities of KMS subsystem will be similar to those presented earlier in Table 7.

5.4 Validation of the Proposal

This proposal described in Section 5.3 was subsequently validated by the same team that participated in the current state analysis and evaluation of the conceptual framework. The proposal for building the roadmap for a KMS in the company was sent by mail. The response was positive and indicated that they were happy with the final outcome. They were especially pleased to see the roadmap for the KMS architecture, a list of tool and functionalities which met the requirements of the case company expressed earlier in the interviews and evaluation sessions. The comments from the key personnel about the roadmap are summarized in Appendix 8.

6 Discussion and Conclusions

This section presents the summary of the study and suggests evaluation of the study, including reliability and validity of research.

6.1 Summary

In the current era, due to globalization and work being distributed across the organizations and countries, people want to connect to partnering organizations for information sharing in a fast and efficient way. The immediate access to information and documentation is helpful in running common projects and can significantly increase the speed and productivity of organizations and individuals.

Presently, more and more organizations are looking for a system which can be described as a knowledge management system (KMS). In this regard, IT can help resolve this problem to a very considerable extent. Building a knowledge portal can help the organization store and share current knowledge, as well as create, organize and reuse the obtained knowledge for future projects. This was the business problem It that the present research addressed.

This research was conducted to benefit a small-sized company which aims at building a knowledge management system to fulfill its need in sharing information with customers in their common projects. The Thesis uses the case study approach to investigate the current situation in the case company and its partners, and develop a system what will meet their needs.

The outcome of this research is a proposal for the knowledge management system (KMS) for the organization which lacks such a system. This system will help the organization to store and share the relevant content with its customers and other users. Apart from this immediate goal, this system can also be used as a platform to create, organize and reuse knowledge. The proposed system is based on the analysis of different existing models to share and manage knowledge. Some of the most famous models, which were examined before developing the one for the case company, are those suggested by Nonanka and Takeuchi (the spiral model for tacit and explicit knowledge, 1995), the Wiig model of building and using knowledge (1993), KM process framework by Bukowitz and Williams (1999), and the technology and human focused KM model by Botha (2008).

In the study, based on the analysis of the case company and its customers' needs, it was found that the KM system should incorporate a set of particular *KM tools*, *features, contents,* and to take into account certain requirements for its *architecture*. These four building blocks became the main components for the proposed KM system. According to the requirements, *the KM tools* should include, among others, the collaboration tools (such as wikis, blog, forum), communication tools (such as e-mail, chat), conferencing tools (e.g. for video conferencing), intranet, extranet, content management systems and document management systems. *The content* which will be shared between the case company and its partners should include, as a minimum, the web content, documents, minutes of meetings, chats, discussions, experts' advice, FAQs, video files, task lists, and similar items. *The features* that the new KMS needs to possess should include collaboration, communication, content creation, content management, data warehousing and intelligent search mechanism. Finally, the proposed *KMS architecture* to address these requirements and put them in practice, should consist of a minimum five *layers* (including the interface layer, access and authentication layer, collaboration intelligence and filtering layers, integration layer) as well as data repositories and cloud applications.

The KMS with this structure meets the case company requirements and will help the company and their customers to access knowledge round the clock, including remote access. Thus, by using this KM system, the organization will be able to communicate and collaborate with its customers and experts whenever and from wherever they need. The system will also help create, store, share, organize and allow users to reuse knowledge. Thus designed, it will save time and efforts of users to organize and search for knowledge which will result in more productivity for the organization and individuals at work. Following the proposal for the KMS developed in this Thesis, the case company decided to build it according to the suggested roadmap to achieve its organizational goals.

6.2 Practical Implications

To put the proposal for the KMS into practice, the case company should also consider following a roadmap for building the KMS in the organization. Building of the suggested KMS can use a four phase process: *Technical Evaluation, KMS Design, KMS Deployment, and Evaluation of KMS.* This building process is summarized in Figure 13 below:

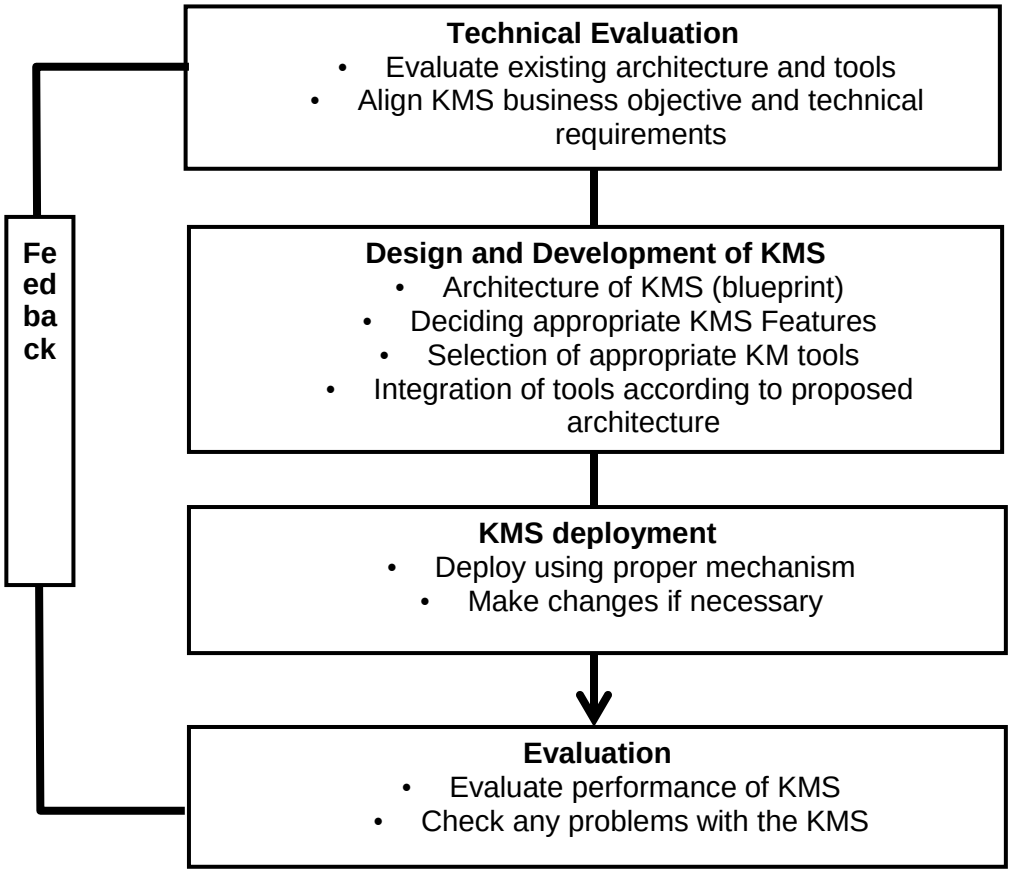

Figure 13. Roadmap for building KMS in the case company.

The four stage process of building the KMS could include the following actions. *The Technical Evaluation* of best possible architecture and tools for building the KMS will be completed in Technical Evaluation phase (done in the Proposal). This process will be based on the business needs of the case company. In the *Design and Development* phase, a blueprint of the system will be designed (drafted in the Proposal). The KMs properties will also be defined which will help the case company in designing of blueprint. Based on the blueprint of KMS, the set of KM tools will be selected and then they will be integrated according to the architecture. The *Deployment phase* will handle the deployment of the KMS in the case company. It will also deal with the necessary changes required to run the KMS practically. Finally, the *Evaluation phase* will involve the customers and users to test/pilot the system and examine the benefits of using the KMS. At this stage, the users will give feedback to further improve the functionalities of the KMS.

6.3 Evaluation of the Objectives vs. Results

The objective of this study was addressed my developing a proposal that met the case company needs. The evaluation of the proposal was done by the case company by validating the suggested proposal and positive evaluation of the outcome (summarized in Appendix 8). The case company also evaluated the conceptual framework according to which the final outcome was later proposed. Finally, the case company decided to establish a KMS according to the suggested roadmap to achieve its organizational goals.

6.4 Validity and Reliability

Validity is a way to measure the authenticity of data. In this research, multiple methods were used to gather the data. The data included research techniques such as semi-structured interviews from various people, their feedback and analysis of tools used in projects. The validity of data was secured by conducting the data collection in two parts. In first part, the data related to the needs of system was collected by semi-structured interviews. This was followed by the examination of the tools used in their projects. In second part of data collection, the conceptual framework based on literature findings was analyzed. In the last round, the data was collected on evaluation of the proposal. Thus, the data was collected from multiple sources by interviews, observations, examination of tools and analysis of feedback.

The researcher was employed as an independent consultant for the case company, working towards knowledge management platform usable by their customers. Following the proposal for the KMS developed in this Thesis, the case company decided to build it according to the suggested roadmap to achieve its organizational goals.

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Appendix 1.

A list of interview conducted with representative of Case Project 1 (Interviewee LL)

Interview Questions	**Answers**
What is your need and your customer's need?	Looking for a system to create and share content with project members and customers. The access right to content should be project-specific. Customers want a reliable and single system to create, store, share and use information.
In project management cycle, when did you need this system?	At every phase of project life-cycle, different tools are needed for creating, storing and sharing contents. If it is in one system, people don't have to look for different tools at different times.
What type of tools are you using for this purpose?	Many tools such as content creation and management tools (Google Docs), document management tools (Google Drive), open source time management (saleforce calendar) and task management tools (saleforce), wikis, chat room (sales force chatter)
Are these tools integrated?	No, these tools are having different interfaces. Access rights are also different.
Are you looking for a centralized system?	Of course yes, will help in project
Do you want your system having single access management?	Yes, all tools and content will be in single location. No need to spend time for looking contents and documents.
What are common functionalities you desire for your system?	Content creation, content storing, content sharing, different versions of documents storing, sharing calendar, task lists, sharing status of projects and contents, single access management
What do you want to share?	Documents related to content of projects, concepts, best practices and procedures of projects, minutes-of-meeting (MOM), calendar, work lists, expert's opinion, discussion, FAQs, wikis, blogs, audio/video files, graphics files

Do you want the information related to best practices and procedures followed in a project should be transferred to another project?	Yes, also in different content format if needed
Do you want to integrate only those tools which you are currently using or ready to integrate alternative as an option also?	Yes, if alternatives give better value propositions
How do you want to present content on user's interface?	In web
Do you want to access content remotely?	Yes, anywhere using web browser
How do you want to organize content in the system?	Most of the information should be on single page. should also be arranged in directory structure according to projects and groups to save space
Do you want your system should store different version of documents?	Yes, useful for backups. Very difficult to be done with google docs. Also difficult to search and retrieve
Do you want your system should create content? And how?	Yes , in different formats such as doc, wikis, blogs, forums, FAQs
Do you want your system should store the opinion of expert's and discussion on specific topic for future reference? And How?	Yes, in the form of discussion, blogs, FAQs. Currently this functionality lacking in the set of tools being used.
Do you want good enough search mechanism to retrieve information?	Yes, will save time and efforts in projects. Missing this functionality in many tools.
Do you want to build your system?	Yes, can be built by company
Who is going to involve in this building process?	the case company's IT division and some other vendors
Have you ever tried building the	Yes, using Salesforce and similar technology. But

similar system?	unable to integrate successfully. Many functionalities were mission. Users were not happy
What was wrong with that system?	Slow search mechanism, not all functionalities were available. Unable to store and share all types of information, such as expert's opinion, discussion. Lack of integration between time and task management
If the right system will be developed how you are going to tell users/customers to use it?	Informing them about the features and benefits of the system. Motivating company employees to use it.
Who will maintain this system?	The case company IT division

Appendix 2.

A list of interview conducted with representatives of case project 2 (Interviewees PL and VP)

Interview Questions	**Answers**
What is your need and your customer's need?	A portal to create, store and share content. The customer's need is also similar type of system with functionality to store and share different types if information
In project management cycle, when did you need this system?	A complete system will help project members in project execution at all stages of project management cycle.
What type of tools are you using for this purpose?	Content management tools provided by customers to store and share contents. Other the case company tools for storing schedule and task list, discussion
Are you looking for a system to store and share information?	Yes, very much needed in project management to save time and increase efficiency
Why do you need such system, if your customers provide you similar system?	The customer's system lack many functionality. It doesn't store different versions of documents. Searching a document of contents is very difficult. Web content is not possible. Hence remote access is not possible
Are these tools integrated?	No
Are you looking for a centralized system?	yes
Do you want your system having single access management?	yes
What are common functionalities you desire for your system?	Storing and sharing of content (documents and web content), efficient search mechanism, content creation should be easy, web-enable, helpful in remote access
What do you want to share?	Documents related to contents, procedures and practices, web content (wikis, blogs, FAQs, expert's opinion)

How do you want to present content on user's interface?	Mostly web content
How do you want to organize content in the system?	Project specific directory structure to save space, easy in searching the document
Do you want your system should store different version of documents?	Yes, good for backups
Do you want your system should create content? And How?	Yes, using web (wikis, blogs, FAQs) also can upload documents
Do you want your system should store the opinion of expert's and discussion on specific topic for future reference? And How?	Yes, in the form of discussion and FAQ's
Do you want good enough search mechanism to retrieve information?	Very efficient search mechanism, saves project time, documents and contents can be located easily
Do you want to build your system?	Yes
Who is going to involve in this building process?	The case company – IT division
Have you ever tried building the similar system?	Yes, unsuccessful. lacking all functionalities of proper system
What was wrong with that system?	Content management was poor, search mechanism was poor,
If the right system will be developed how you are going to tell users/customers to use it?	Involve customers and project members in using it. Use in project execution
Who will maintain this system?	IT division

Appendix 3.

A list of interview conducted with representative of case project 3 (Interviewee TN)

Interview Questions	**Answers**
What is your and your customer's need?	Good IT system to store and share contents, documents, best practices, wikis, discussion, expert's opinion
In project management cycle, when did you need this system?	From beginning to the end of project management cycle, such a tool is needed for various purpose
What type of tools are you using for this purpose?	Many tools, Google docs (for creating and storing content), google drive (for storing documents), salesforce chatter (the case company's tool for discussion) and some other tools for calendaring, task lists
Are these tools integrated?	No
Are you looking for a centralized system?	Yes
Do you want your system having single access management?	Yes
What are common functionalities you desire for your system?	Content creation and management (documents, minutes of meeting, task list, web content, such as blogs, wikis, chat, expert's opinion, FAQ's)
What do you want to share?	content of documents and best practices used in project, task list, blogs, wikis
Do you want to integrate the tools you are using or ready to accept alternative as an option also?	Can use both existing tools and alternatives whichever gives better return
How do you want to present content on user's interface?	On web, easy to access remotely
How do you want to organize content in the system?	In project specific directories and group specific contents
Do you want your system should store different version of documents?	Yes

Do you want your system should create content? And How?	Using web mechanism. Should upload documents also.
Do you want your system should store the opinion of expert's and discussion on specific topic for future reference? And How?	Yes, in forums
Do you want good enough search mechanism to retrieve information?	Yes, search engine should be very good. Useful in tracking contents in the system
How will you store the contents on your system?	In databases or in clouds
Do you want to build your system?	yes
Who is going to involve in this building process?	IT division of the case company and may be some externals
Have you ever tried building the similar system?	Yes, not very successful
What was wrong with that system?	Not able to get all functionalities needed. Poor architecture, poor selection of tools
If the right system will be developed how you are going to tell users/customers to use it?	involve different project members to use system for their project specific tasks
Who will maintain this system?	IT division

Appendix 4.

A Tabular View of Case Project with problem area in KMS

Features of KMS available with existing infrastructure of tools used by the case company and its customer	Case Project 1	Case Project 2	Case project 3
Diverse set of tools for Project Management	Yes	Yes	Yes
Integration fo tools	No	No	NO
Single access management	No	No	No
Task Management	No	No	No
Time management (calender)	Yes; separate tool	No	Yes; separate tool
Content Management	No	No	No
Document management	Yes	Yes	Yes
Efficient search and retrieval of content	No	Very difficult	No
Ontology and taxonomy of content	No	No	No
Access for content from remote location	Yes	No	No
Knowledge Warehousing	Yes; partially	Yes	Yes: partially
Usability	Difficult	Difficult	Difficult

Appendix 5.

Feedback of key personnel for the architecture of KMS

Architecture of KMS	**Case Project 1**	**Case Project 2**	**Case Project3**
Interface layer	Yes	Yes	Yes
Access and Authentication layer	Yes	Yes	Yes
Collaboration Intelligence and Filtering Layer	Yes, only filtering mechanism; because number of users are small	Yes, both adaptation and filtering layer; in big companies numbers of users are big	Yes, only filtering mechanism
Application layer	No, applications are embedded with data base and cloud services	No	No, applications are embedded with data base and cloud services
Transport layer	No, In current set of data bases and cloud services, there is no need of it	No, In current set of data bases and cloud services, there is no need of it	No, In current set of data bases and cloud services, there is no need of it
Integration layer	Yes	Yes	Yes
Data repositories	Yes; also cloud services	Yes	Yes; also cloud services and virtual data warehouses

Appendix 6.

Feedback of key personnel for the Functionalities of KMS

Features of KMS	Case Project 1	Case Project 2	Case Project 3
Collaboration	Yes	Yes	Yes
Communication	Yes	Yes	Yes
Content Creation	Yes	Yes	Yes
Content Management	Yes	Yes	Yes
Networking	Yes	Yes	Yes
Artificial Intelligence	Only intelligent search mechanism, no use of past search activity of users	Good to have only search mechanism	Good to have only intelligent search mechanism

Appendix 7: Feedback of key personnel for the KM tools

KM Tools	Case Project 1	Case Project 2	Case project 3
Collaborative tools (wikis, blogs, forum)	Yes	Yes	Yes
Communication tools (e-mails, chat)	Yes	Yes	Yes
Content management systems	Yes	Yes	Yes
Document management systems	Yes	Yes	Yes
Data warehousing tools	May be	Good to have	May be
Artificial intelligent tools	Only search tool	Search tool	Intelligent search tool
Networking tools	Intranet and extranet	Extranet	Intranet and extranet

Appendix 8: Evaluation of the Proposal

Questions	Case project 1	Case project 2	Case project 3
Are you happy with overall content of proposal?	Yes	Yes	Yes; very happy with a roadmap for establishing KMS in the organization
Are you satisfied with the five layer architecture of KMS?	Yes	Yes	Yes
Are you happy with the functionalities with KMS?	Yes	Yes	Yes; also would such as the system to be scalable and incorporates future need also
Are you happy with the tools recommended for the system?	Yes	Yes	Yes; would such as to see the integration and deployment